PUBLIC BUILDINGS

WILLIAM PAUL GERHARD

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SANITATION

OF

PUBLIC BUILDINGS

BY

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PREFACE

THIS book is intended to discuss some features of sanitation in PUBLIC BUILDINGS, with special reference to Drainage, Water Supply, Lighting, and Ventilation.

Among public buildings, we may distinguish:

(1) Those having a permanent population, both in daytime and at night, such as the hospitals of all kinds, orphan asylums, homes for aged people, and prisons or jails;

(2) Those having a large gathering of persons only during the day, such as schools, court-houses, markets, and abattoirs;

(3) Those in which people congregate for a few hours only, either in day time, or in the evening hours, such as churches and theatres.

Of the buildings mentioned, I have selected the hospitals, or the buildings for the care of the sick, the feeble-minded, or the injured as being the most important ones; next the churches and theatres, where very large crowds assemble during a few hours, either for worship or for amusement; following these I speak of schools, where large numbers of children are crowded together during the day for instruction, education, and mind improvement.

Of much importance, sanitarily, are finally the market buildings, where the food supplies for the population of cities are kept for sale, and not less, the abattoirs, where the meat supplies are prepared for the market.

Accordingly, I have divided the book into five chapters, viz.:

I. Hospital Sanitation.
II. Theatre Sanitation.
III. Church Sanitation.
IV. School Sanitation.
V. Sanitary Features of Markets and Abattoirs.

The volume is, in some sense, a continuation of the author's work "SANITARY ENGINEERING OF BUILDINGS," which is devoted largely to the sanitary work of dwelling-houses, apartments, and tenement-houses.

Public bath-houses will be discussed in a separate volume, entitled "Modern Baths and Bath Houses," which the publishers of the present book expect to bring out before the end of the year.

Inasmuch as there is, at the present time, no American book published, in which the subjects mentioned are treated in a practical way, it is to be hoped that this volume may meet the same kindly reception which was accorded to previous writings of the author.

WM. PAUL GERHARD, C.E.

July, 1907.

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HOSPITAL SANITATION

I.

HOSPITAL SANITATION.

THIS subject is one of such magnitude as to render it impossible to deal with the same exhaustively in the short limits of a single chapter. Nevertheless, I shall try to discuss, be it ever so briefly, the matters which are of most importance, namely the plumbing, the water supply, and the sewerage.

Let us assume, by way of introduction, that both the architect and the Building Committee of a hospital have reçognized the fact that the crowding together of a very large number of disabled and diseased persons in a confined area requires the most complete and carefully considered sanitary arrangements. The application of modern sanitary principles and the installation of approved sanitary appliances, which are necessary even in the case of ordinary dwellings, wherein only a few healthy persons are sheltered, become of paramount importance in the case of sick and helpless patients.

Hence the first axiom in hospital construction should be that such buildings should under no circumstances be monumental or palatial structures. The outer appearance of the buildings should be characterized by severe simplicity. No money should be appropriated or spent for purely architectural display, for ornamentation or for outside show. On the other hand, everything should be done to make the buildings safe and healthful, and it should be the constant aim to secure the best hygienic construction and the latest approved sanitary appliances. (See note at end of chapter.)

I also wish to point out and lay stress upon the necessity of engaging the services of a hydraulic and sanitary engineer at an early stage of the work, for even in the selection of the site for a hospital, questions of drainage and water supply may and will arise, which can be decided in the best manner by the thorough knowledge and practical experience of such a specialist.

Practically, it makes no difference whether the hospital building is intended for a general hospital, or is to be one of the various special hospitals, such as a fever hospital and hospital for infectious diseases, or a lying-in hospital, a surgical hospital, a military hospital, a children's hospital, or a hospital for insane patients. The general principles and arrangements remain about the same, though each may, in addition, have some special requirements.

The two great general sanitary requirements for hospitals, whether small cottage or village hospitals, or large city hospitals of many stories, are:

(1) Plenty of light and fresh air, particularly for the wards, for the toilet-rooms, the pantries and closets.

(2) Absolute cleanliness, inside as well as outside of the buildings.

It will be well to bear both requirements constantly *in mind* in the following discussion. A perfect system of water supply, sewerage, plumbing, and ventilation will help considerably in securing both conditions.

1. **Drainage and Sewerage.**—In determining the site for the building, the drainage and sewerage must at once be taken into consideration. Where the hospital is to be located within the city limits, the problem generally is a simple one and presents few, if any, difficulties, for as a rule, a city sewer will be available for connection at not too great a distance. But, if the building is to be located in the outskirts of a town, or in the country, where there are no public sewers, it will be necessary to determine at once upon a general sewerage scheme. The first matter to be settled will be the position of the main sewer outfall, for upon this will depend the layout and the grades of the sewer laterals and branches, and the arrangement and course of the house sewers.

Another point of importance, which requires early consideration, is the question whether the sewerage shall be arranged on the "separate" or on the "combined" system. In the first system, the rain-water from roofs, yards, and roadways is excluded from the hospital sewers; in the combined system, storm-water as well as foul sewage are received in the same sewer channels.

As a rule, it is much better to deal with the rainfall separately. The rain-water can often be stored in cisterns and may be utilized in the laundry or in the boiler-room, and this might with advantage be done much more often than is actually the case. Again, it should be borne in mind that the sewage proper from a hospital often has to be purified or dealt with in a special manner, before it can be discharged into a water course. In all such cases, the admission of a portion or all of the rainfall increases the volume of sewage to be treated—which, moreover, sometimes has to be pumped—and hence renders any method of sewage purification more expensive and difficult in management. Another consideration bearing upon economy in construction, refers to the size of the main sewer and of the lateral branches. Where the rainfall is admitted to the sewers, their sizes must be calculated in proportion to the maximum amount of rainfall to be removed. On the other hand, where rainfall is excluded or dealt with separately, the sizes of sewers will be greatly reduced, and a more uniform and constant flow will be secured, which in turn will make the sewers more self-cleansing.

In the majority of instances it is undoubtedly better to arrange the sewerage of an isolated hospital according to the "separate system."

In designing a sewer system for a hospital, the following chief requirements must be fulfilled. All sewers should be self-cleansing, free from deposits, and absolutely water-tight. Ample ventilation should be provided to the main sewer as well as to the laterals, and provision made for keeping the sewer lines accessible for inspection and cleaning.

The alignment should be as straight as possible, and where changes in direction are required, they should be made with easy curves in manholes. All junctions should be made with acute-angled branches and never at right angles. Sewers should be laid at the proper depth and on true grades, and the fall should be as uniform as possible.

Manholes and lampholes for inspection should be placed at suitable intervals on all mains and laterals. Provision for daily automatic or periodic hand-flushing should be made at the head of all laterals. Sewers should be well ventilated, which is generally accomplished by the use of ventilating covers on the manholes.

Hospital sewers are rarely required of such dimensions as to necessitate the construction of brick sewers. As a rule, they consist of pipe sewers, proportioned in size to the maximum volume of sewage which they may be called upon to carry. The best available material for small sewers is vitrified sewer-pipe, which is more smooth and impervious than cement pipe. Iron sewer-pipes are used near buildings, also where sewers necessarily cross under the basement of buildings, and where the sewers must be laid in made ground.

The joints of vitrified pipe sewers should be made tight by means of Portland cement, care being taken in making the joints that no cement protrudes on the inside of joints where, in hardening, it would form a serious obstruction to the free and uninterrupted flow of sewage. The pipes require to be laid on a firm bearing to prevent subsequent breakage, and in yielding ground it is desirable to lay them on boards or concrete foundations. All drains for sewage should be tested when laid, first, as to their tightness, by a water-pressure test, and second, as to their inside smoothness and ability to remove sewage matters, which is ascertained by passing a wooden ball through the pipes from manhole to manhole.

Manholes should be located at distances of about 200 or 300 feet, and at every 100 feet there should be lampholes to facilitate the inspection of the pipes from the manholes. The bottom of sewer manholes should be formed as a semi-circular channel, molded in cement, and the sides of the bottom should have a steep inclination to prevent sewage matters from becoming stranded.

Where the separate system of sewerage is adopted, the storm-water falling on roofs and yards may be taken care of in one of three ways, i.e., it is either collected and removed by separate rain-water drains, and discharged into a nearby water course, or else it is gathered in rain-water cisterns usually built underground, or finally, it may be allowed to run off on the surface and into road ditches, or into some water course.

Where the ground, upon which the hospital buildings are located, is damp, wet, or full of springs, drainage of the soil is advisable. This is accomplished by special lines of agricultural or land drains, consisting of porous, unglazed earthen round pipes, laid with open joints in deep trenches. The sewers for foul water should never be made to fulfill the double duty of removing the sewage and draining the land. The subsoil water, after being gathered in land drains, may be suitably disposed of by discharge into an open water course. Similar tile drains may be necessary along the footing courses of the foundation walls.

2. Sewage Disposal.—Where the hospital sewers connect with a city sewer system, the disposal of the sewage need not be further considered, except that cases may arise where it will be advisable to arrange for utilizing a part or the whole of the sewage on hospital land for farm irrigation purposes during certain portions of the year. On the other hand, where there is no regular sewerage system, the problem of sewage disposal will confront the hospital authorities. The simple crude discharge of sewage into a water course is no longer approved, except where the buildings are located near a very large stream, when the immediate dilution and the rapid current would render the sewage innocuous. Should the water course be one which supplies drinking-water to cities or towns, located below the hospital, the discharge of sewage into it is generally, or else should be, prohibited by State laws or by the State Board of Health. Where it is nevertheless attempted, it will generally lead to serious trouble or litigation, arising from the increasing pollution of the stream.

It is, therefore, best to prepare from the start some plan whereby the sewage can be purified. All plans for the simple straining of sewage, or for subsidence in sewage-tanks or large cesspools, should be discountenanced, for in both cases only the coarser, suspended impurities are held back, leaving the sewage of much too foul a character to be discharged into any stream.

As a rule, it will be best, where sufficient hospital land at suitable elevation can be obtained, to apply the sewage to the soil, and to effect its purification by irrigation on, or by filtration through, land. Very satisfactory results may also be obtained by intermittent filtration through artificially-prepared sand and gravel filter-beds.

In some cases it may become necessary to use pumps to lift the sewage on to land suitable for sewage farming. The purification of sewage is accomplished either by broad irrigation, or by subsurface disposal or by intermittent downward filtration, the choice of the system depending upon the available area of land and the proximity of the same to the hospital buildings.

The land selected for sewage disposal should be either naturally porous or artificially under-drained. The sewage farm should also be as remote as possible from the source of water supply, if this is a local one. It is generally advisable to intercept all solid matters, papers, rags, etc., either by a straining-chamber or by an intercepting tank, both of which will need almost daily attention and cleaning. This is particularly necessary in the case of subsurface irrigation, for otherwise the small absorption tiles, through which the sewage is distributed, will soon clog up and cause the sewage to break up on the surface. Intermittent application of sewage to the soil is essential, otherwise the ground may become saturated and swampy.

Whatever the system of sewage disposal selected, its distribution on the land and the management of the sewage strainer and flush-tank require *intelligent* attention, for without it the result is almost sure to be a failure, which, owing to the non-acquaintance with the essential requirements of the system, is only too apt to be attributed to faults in the system of disposal.

There are cases where the area of land available for sewage disposal is rather small. It may, then, be advisable to combine a system of chemical precipitation with subsequent sewage utilization on land. Where no land at all is available, or where suitable land is held by the owners at too high a price, it may be necessary to purify the sewage by a chemical process, or by a process of æration, by biological methods in septic tanks and in contact filter-beds, or finally by an electrical purifying process. The chemical and electrical methods will be generally found more expensive in first cost and in maintenance and more difficult in management, than a system of disposal by application on land. On the other hand, biological processes may in many instances prove to be more economical, both in first cost and in management, than land treatment.

A crude method, which is unfortunately too often resorted to, where no sewer and no large water course are available for the discharge of the hospital sewage, is to lead the sewage to large cesspools, constructed with loose sides and open bottom, from which the sewage is permitted to escape into the lower strata of the soil. This method of disposal cannot be approved from a sanitary point of view, as it involves a long storage of putrescible matter, and leads to a pollution and defilement of the soil, and also quite often to the contamination of springs or wells. A leaching cesspool is a sanitary abomination, and it cannot for a moment be considered an attempt even of solving the difficult question of the disposal of sewage.

Privy-vaults should likewise never be used for hospitals. Where outdoor conveniences are required, earth-closets should be erected. If not located too near the buildings, these will be found unobjectionable and easily managed, and the enriched dry earth forms a valuable manure for use on the hospital farm. It must, however, be remembered that such earth-closets require daily attention, and emptying and cleaning at frequent intervals.*

3. **Water Supply.**—Water supply and sewerage are closely allied together. No hospital, having a general system of water supply, should be without a sewerage system, and on the other hand, every hospital provided with sewerage facilities requires an abundant water supply to secure the flushing out of the plumbing fixtures, waste-pipes, and sewers. Where only one of the systems is provided, serious trouble is sure to result.

An abundant supply of good and pure water is a prime necessity. More water is required for hospital buildings than for other institutions, in order to insure the fastidious cleanliness which I have characterized as one of the chief requirements of such buildings. Not only must provision be made for the large volumes of water required for personal cleanliness, for bathing, scrubbing, for use in the large laundry, and in the boiler-house, but a large surplus of water, stored under a sufficient pressure, is required for fire protection purposes.

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* See the author's book, "The Sanitation, Water Supply, and Sewage Disposal of Country Houses." D. Van Nostrand Co. 1907.

In the case of city hospitals, a public supply is generally available, and arrangements can usually be made for a large supply main for the institution, which main should be not less than 6 inches in diameter. Unless the city is supplied from a private water company, water is generally delivered to hospitals, the same as to other charitable institutions, free of charge. An unstinted use of this important element throughout the hospital is thus secured. But isolated hospitals located away from the densely-populated centres of cities, village hospitals, and hospitals for insane, usually have to provide a private and independent water system. In arranging and designing such a system of water supply the following are points of importance, which should be taken into consideration.*

First, concerning the quantity to be provided, this should be very large and ample. Fifty gallons per head per day should be regarded as a minimum supply. In many hospitals a much larger quantity is consumed per day, and in some of the State hospitals for insane patients the average daily quantity exceeds 200 gallons per day, which is partly explained by the lavish use of water for bathing the patients, and partly by the use of automatic flushing arrangements for the water-closets and urinals in the insane wards. Where water is pumped, it is desirable that the supply be controlled and the waste checked as far as possible, to

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* See also the author's book, "The Sanitation, Water Supply, and Sewage Disposal of Country Houses."

reduce the annual expense for the fuel used in pumping, a matter to which far too little attention is generally paid.

The quality of the water supplied to a hospital should be pure, suitable for all purposes, and above the slightest suspicion of contamination. Before determining upon a source of supply, which appears to be favorable in all other respects, it is necessary to make a thorough examination of the water. This involves a chemical quantitative analysis, to determine vegetable and animal impurities; a microscopical examination; a biological analysis to determine the number of bacteria in the water and the presence or absence of any disease germs; and finally, a sanitary inspection of the source of supply and its surroundings.

In the case of springs and wells, the inspection may be confined to the immediate surroundings of the same, but in the case of surface-waters, impounded by storage dams, the entire water-shed should be visited and all sources of soil or water pollution carefully studied to ascertain if they can be eliminated. Where water is to be drawn from rivers or flowing water-courses, both banks of the stream, for quite a distance above the point of the proposed intake of water, should be examined for possible sources of pollution, such as sewers, drains, industrial wastes, etc. As soon as a source of supply is determined upon, the most stringent measures should be taken to avoid entirely all subsequent pollution.

It is likewise important that the water should be delivered to the buildings under a good pressure, not only because this insures a better supply and a constant head on the upper floors, but also on account of the requirements of fire protection to the hospital. The pressure should be ample to give a good fire stream in the attic of the buildings. If such pressure cannot be secured otherwise, it is necessary to provide storage-tanks at high elevations, generally in tank-towers forming part of the building, or else in outside elevated tanks to which the water must be pumped, or finally by means of pressure tanks located underground or in the cellars of buildings.

The source of water supply may be a spring cropping out from the rocks, either at an elevation much higher than the hospital, or perhaps located at a lower level, in which case a pumping-station must be erected. It is important to ascertain by gaugings the yield of springs during a long-continued period of drought, for many springs are liable at such times to flow a much smaller volume, or to dry up altogether.

A single well, or a series of wells, may constitute the supply, and the wells may be either shallow or surface wells, or else deep wells, or, finally, flowing (so-called artesian) wells. It may be said, generally, that shallow wells are undesirable as being too liable to pollution from surface drainage or by soakage from privies or cesspools. Deep wells, while safer from pollution, may not yield water fit for all uses; indeed, the water is often too hard, i.e., highly charged with mineral salts and not suitable for boiler or laundry use. Heavy continued pumping from deep wells often causes their subsequent pollution by the lowering of the water level and the gradual drawing upon the underground sheets of water at further distances.

Again, water may be drawn from a lake, pond, or sheet of water, fed either from surface water, or more often from subterranean springs. Sometimes, water is pumped to a hospital from a river or creek and purified by filtration, or else an artificial storage-reservoir is formed in a drainage district by throwing a dam across the lower end of the valley, thereby collecting or "impounding" the water from the drainage area or watershed. This latter must be free from all pollution from sewage or field manure, and the bottom of the reservoir should be thoroughly cleaned from all dead vegetation. Finally, water suitable for many purposes, can be obtained, where other sources are unavailable, by collecting the rain-water falling from the roofs of the buildings in underground tanks or rain-water cisterns. As a rule, however, the quantity so gathered would fall far short of the demands of a hospital.

Whatever the source selected may be, an intimate knowledge of hydraulic engineering is required to avoid a mistake in the choice. Each source of supply should be judged as to its character by making the examinations and analyses aforementioned. The special points, in addition to general wholesomeness, to be looked into are the hardness of the water, which determines its availability for the steam-boilers and in the laundry, and also the possible action of some waters on metals like lead or iron, for this may have a bearing upon the material chosen for the service-pipes and for the water-tanks.

Regarding the manner in which water is supplied to a hospital, we may distinguish between a gravity supply and a supply by pumping. The former is, of course, much to be preferred on account of economy in management, provided the pressure is ample to insure fire protection.

Where pumping is required, we have four systems which I name in the order of their relative superiority, viz: Pumping to an elevated reservoir; pumping into closed water-pressure tanks in conjunction with air pressure tanks and air compressors; pumping the water into a stand pipe or an elevated tank; or finally pumping directly into the water mains. The topography of the hospital grounds generally determines the question whether a reservoir or a stand-pipe are preferable. Where sufficiently elevated ground cannot be found upon which to build a reservoir, an elevated tank or a stand-pipe may be used, or else a pressure-tank system. A stand-pipe is more economical in first cost than a reservoir, particularly if the latter is to be a covered reservoir, which has some advantages over the open reservoirs. Pumping directly into the mains cannot be considered as good as any of the other systems named, for it has the great drawback of providing no surplus storage of water available in case of fire, though this latter drawback also applies in part to stand-pipes.

The water supply for a hospital must frequently be purified on a large scale before it is suitable for use. This may be done either in large sand-filter basins or else by mechanical filter-plants. Of all methods of filtering water on a large scale, sand filtration as practiced in many European water-works is undoubtedly the best, though it is slow in action and expensive in operation. Good results may also be obtained by using pressure or mechanical filter plants, which filter the water largely by straining and often secure a perfectly bright and clear effluent by the addition of alum, causing a chemical precipitation and purification. If alum is used, however, care should be exercised not to use too large a proportion of the same, for this would result in some free alum appearing in the filtered water and possibly rendering the same injurious to health, or, at least, making the same unfit for use in the laundry, by reason of the rusting of the water mains, or unfit for use in the steam-boilers, owing to the danger of the formation of boiler incrustations. All filtration plants should be arranged with a view of easy cleaning of the filter plant, otherwise the filters may soon become worthless.

The drinking water of a hospital should always be filtered by means of one of the different household filters in candle form, consisting of porcelain or infusorial earth, such as the Chamberlain-Pasteur filter or the Berkefeld filter, which latter, according to recent investigations, is not quite so slow in action as the former, and bids fair to take front rank among germ-proof drinking-water filters. The filtering material used in both filters named should be cleansed daily by brushing and should be sterilized from time to time to attain good results and to maintain a germ-proof condition *of the filter.* Unless this is done with regularity, the boiling of impure water is better than any system of household filtration.

When rain-water is stored and collected in cisterns, these are usually built underground outside of the building; they must be built perfectly water-tight, and all danger of contamination of the cistern water must be avoided. The overflow of a cistern should never be connected with a sewer or drain for foul water, but may be connected with the land drains, or else a special pipe should be carried and discharged on the surface or into some ditch or road gutter. The outlet should have a strainer to protect the pipe from mice and other animals. The cistern should be covered and be well ventilated. It must be easy of access and frequently cleaned out. If possible, reversible rain-water leader connections should be used, to throw away the first washing from roofs which are apt to be impure, or else a small filtering device can readily be attached to a cistern to intercept leaves, soot, and other dirt from the roofs.

Except in cases where a high pressure of water is carried in the mains, hospital buildings require large water-tanks. These are placed either on steel or iron tower structures, or else in the highest part of the building itself.

House service-tanks should likewise be constructed with a view of preventing any pollution of the water. They should be built of boiler iron, of slate, or of wood, either rectangular or circular in shape. Smaller tanks are built of wood, lined with tinned copper. Lead tank linings are objectionable on account of the danger of lead-poisoning, and galvanized iron water-tanks are unsafe for similar reasons. House tanks should be provided with covers to exclude dirt and dust, they should have ventilation to the outer air, and means for frequent emptying and cleaning, and the covers should be arranged with hinged trap-doors to give access to the tank for inspection. They must be so located as to prevent all possibility of any water contamination by gases from soil-pipes or odors from plumbing fixtures; the tanks and pipes should also be protected against frost. The overflow pipes from house tanks should discharge into the roof gutter, or else deliver over a trapped and water-supplied sink in the basement. Never should an overflow from a water tank be connected with a soil-pipe or sewer.

From the stand-pipe or the pressure reservoir the water is conducted to the hospital buildings through lines of distribution-pipes, which are laid in the ground at such a depth that the possibility of freezing is excluded. Mains generally consist of cast-iron pipes, of suitable thickness, laid with well-caulked joints, with the necessary fittings or "specials," and provided with gate valves to control the flow of water through mains and laterals, also with branches to outside fire hydrants. Water mains should be of ample diameter to secure a full supply to the buildings, and for fire protection they should not be smaller than four, or better even, six inches in diameter. In order to prevent stagnation of water in the mains, and to insure a supply in case of the bursting of a water-pipe, it is preferable *to arrange the* distribution system on the "circulating plan," wherein all dead ends of piping are avoided.

The service-pipes in a hospital may be either lead or iron pipes, the latter generally made galvanized to prevent rust. Certain waters have a detrimental action upon galvanized pipes, but as a rule such pipes can safely be used. They are conveniently put up and run, and for hospitals for insane in particular they are preferable to lead pipes, as not being so liable to be injured by blows or other malicious interference.

Where water is pumped, the pumping plant should be designed with skill and due regard to economy and management. Pumps should always be provided in duplicate to guard against a water famine, which in a hospital would be very disastrous in case of a breakdown of the machinery. Unless the gravity supply insures a strong fire pressure, it is desirable to provide and fit up in the pump house a special fire pump, which may be either a rotary pump or else a direct-acting steam pump. Where electric currents are available for power purposes, the pumps are often run by electricity instead of steam.

4. Plumbing in General.—Having now discussed the general topics of outside water supply, the sewerage of a hospital and the disposal of the sewage, and determined how pure water may be supplied for use, and how the same water, after use, may be promptly removed together with all its organic impurities and dejecta from the persons, and how it can be made innocuous before discharge into a stream, I will next consider the inside plumbing apparatus and plumbing-pipe system adapted for hospitals.

Plumbing and house drainage, as applied to hospitals, are governed by the same general rules and requirements enforced in other kinds of buildings, and it is therefore necessary to describe but briefly the chief general features. A certain number of points of more special application will be noticed afterwards.

In general, I may say that the arrangement of the plumbing should be as simple and direct as practicable. Where the buildings are two stories or more in height, the aim of the architect in designing the floor plans should be to locate the plumbing in vertical groups, in order to reduce the number of pipe lines to a minimum. Horizontal branches should likewise be avoided as much as possible on account of the difficulty of giving a sufficient fall to the waste-pipes.

The plumbing for hospital wards is best located in an annex pavilion, cut off from the ward by a well-ventilated lobby or short corridor. Rooms which contain plumbing, should never be entered directly from the wards, and this is of paramount importance in the case of surgical wards. The foregoing remarks need not apply to the plumbing of the administration building or that of the kitchen, pantry, and laundry.

The plumbing system, which often for convenience's sake may be subdivided into several divisions, consists of vertical lines of soil- and waste-pipes. In the basement or the cellar, as the case may be, all these lines are gathered and connected into lateral drains, which again join to form main drain lines, or house sewers, as they are more appropriately called. Wherever practicable, drains should be kept above the cellar floor and supported by brick piers, or hung from beams by pipe-hangers or clamps. A hospital building will have one or several lines of house sewers, according to its size and extent. It is desirable to restrict the size of the largest house sewer within the building to six inches in diameter. Each line of house sewer should have a running or main trap, and each trap should have a fresh-air inlet on the house side of said trap, extended to a point outdoors, well remote from windows and from fresh-air ducts of the heating apparatus. It is best to extend the fresh-air pipe two feet above grade, and to finish it with a quarter bend covered as a protection against obstructions with a brass air inlet grating. For city hospitals, it may be difficult to find a suitable place for the air inlet, but I warn against locating it in a brick box with iron grating set flush in the sidewalk near the curb, as the gratings invariably become obstructed with mud and dirt, and in winter with snow and ice. The main traps of all house sewers should have cleanouts and should be kept accessible by manholes built around them. Where a hospital is composed of a group of buildings, I hold it is preferable, in order to isolate one building from the other, to place a running trap on the line of house sewer for each of the buildings.

All soil and waste lines should be carried vertically upward and be extended at least the full size through the roof for ventilation, all pipes smaller than 4 inches being increased to this size at the roof, to prevent their becoming closed up in winter time by hoar-frost.

Soil-, waste-, or vent-pipes should never be run to and terminate in brick flues, as the bricks are porous and liable to absorb sewer air and to retain disease germs.

Where deviations from the vertical line must necessarily be made, the offsets of vent lines and vent extensions above the highest fixtures should always be made under an angle of at least 45 degrees from the horizontal line in order to prevent any rust from lodging in the pipe and thus obstructing the free vent outlet at the roof.

All plumbing in a hospital building should be separately trapped, and the traps should be set close to the fixtures. Traps should be arranged in such a way that they can by no possibility lose their water seal either from self-siphonage, or from suction caused by discharge of other fixtures on the same line, or by evaporation, or by back-pressure. One method of accomplishing this end is to run vertical lines of air- or vent-pipes and to attach branches from them to the highest point of each and every trap. Practically, this prevents siphonage in nearly all cases, but a great complication of the system and the possibility of dangerous by-passes are thereby created. The same object can, without doubt, be attained by simpler means, consisting in using traps with deep water-seal for water-closets, and so-called non-siphoning water-seal (not mechanical) traps under other fixtures, where the same are located within 4 or 5 feet from a well-ventilated line of soil- or waste-pipe. Long branch wastes must in all cases be extended separately up to the roof, but the traps under the branches do not need the "back-air pipe." I call the improved system the "one-pipe system" to distinguish it from the prevalent "two-pipe system," which is, in my judgment, unnecessarily complicated and much more expensive.

The new method, if judiciously applied, renders a plumbing system fully as safe as the old-fashioned and cumbersome method.

Going a step further, we may apply this rule of utmost possible simplicity to all parts of the plumbing work. Another axiom to be borne in mind is to make all parts of the plumbing system accessible for inspection and repairs. Mechanical appliances liable to get out of order should be avoided. Mechanical traps in particular cannot be approved except where there is only clean water flowing through the waste-pipes. Water-closets with mechanical appliances are an abomination and should never be tolerated.

A further modern maxim, of particular importance in the case of hospital buildings, is to avoid all wood-work around plumbing fixtures, to abolish pipe-casings and wooden enclosures to fixtures. All plumbing in a hospital should be *exposed plumbing*. Every line of pipe, whether soil, waste, vent, or supply line, should stand free from the walls. I cannot lay sufficient stress upon the importance of this method of construction. Water service-pipes should not be put in walls or horizontally between floors, because if so placed, hidden leakages of water will cause more damage to decorated walls and ceilings, and also because pipes in walls, if these are outside walls, are very liable to freeze in cold weather and to cause damage by bursting. I likewise urge doing away entirely with all wall recesses or pipe-casings for soil- or vent-pipes, because in case of the joints leaking water or sewer air, it is difficult or impossible to reach the pipes to detect the leak. I also disapprove of pipe casings in front of wall recesses, because the enclosed spaces constitute very undesirable runways for mice, rats, and roaches, and form breeding-places for vermin. Whoever has seen the untidy, nay, sometimes filthy condition of the interior of such pipe-casings, and compared the same with a good example of modern exposed work, will never want to return to the old-fashioned methods of doing plumbing work. Another objection to the pipe recesses is that they act as convenient channels or flues for carrying foul odors from the cellar or lower floors of a building to the upper floors.

There is absolutely no good reason why plumbing-pipes should not be kept in sight in toilet-rooms, and in pantries and through closets. Open pipes can always be examined and tested, and, if required, tightened in the joints or repaired in case of breaks. Where they pass through floors and ceilings, the openings can be efficiently closed with plaster, and thus no inviting corners or spaces are left for waterbugs and vermin. It should also be noted that where plumbing work remains exposed to the light, the mechanic exercises greater care in doing his work, therefore the general quality of the work will be improved. Fortunately, the prejudice of architects and owners against open plumbing work has been overcome, and a new era in house sanitation has therewith begun.

I must not omit mentioning that, where this can be avoided, no plumbing-pipes connected to the sewer system should pass through the wards or through the operating-rooms of a hospital.

With open plumbing work, perfect cleanliness is much more readily maintained, and it is likewise possible to exert more vigilance in regard to the plumbing fixtures and their condition.

Elaborate display and efforts to make the plumbing work ornamental, possibly at the expense of simplicity and substantial workmanship, are evidently out of place in the ward plumbing of hospitals. The same is true of nickel-plated brass piping. It is a mistake to suppose that exposed plumbing cannot be installed without the use of nickel-plated brass pipe. Lead and iron pipes, and even brass pipes and fittings left rough outside, can be made to look well by bronzing with aluminum bronze or by enamel painting.

5. Some Plumbing Details.—Before discussing hospital plumbing fixtures, I must consider some further details of plumbing work, such as the material, sizes, and arrangement of pipes, and I shall try to give this information in as condensed form as possible.

No earthen pipes should be used anywhere within the walls of a hospital. From a point about ten feet outside of the foundation walls, the house sewers should consist of extra heavy cast-iron pipes. Wherever pipes are carried above the cellar floor, heavy wrought-iron pipes may be used. The soil, waste, and vent-pipes may be either extra heavy cast iron, or else heavy wrought-iron pipes. The former pipes are jointed with lead-caulked joints, whereas wrought-iron pipes are put together with screw joints. Screw joints are superior to caulked joints, being more durable and permanently tight. For joints in cast-iron pipes a new material has been put forth recently, consisting of a mixture of steel and iron filings made into a paste which hardens quickly and becomes water-tight. This material, called "Smooth on Joints" is the invention of a practical chemist who has made exhaustive tests of it before putting it on the market. I have had the same applied to several lines of cast-iron pipe and found it to be quite tight under the water-pressure test. There is not, however, sufficient experience on hand regarding its permanency and durability. Should it prove to remain tight, it would certainly be a great improvement over the ordinary caulked joint, and not the least advantage of the new material would be that it does away with the necessity of a plumber's furnace for melting the lead. It would thus greatly reduce the fire risk in non-fireproof buildings during construction.

Wrought-iron soil-pipe systems are constructed of pipes made rustless, either by galvanizing, or by an asphalting process. Plain, so-called black iron pipes should never be used for house drainage purposes. For vent lines it is better to use galvanized pipe, as these are less liable to rust than asphalted pipes. For soil-pipes I prefer the latter on account of their greater smoothness.

The fittings for wrought-iron pipes should not be the ordinary steam-fittings, but they should be the recessed or drainage fittings, which were introduced years ago by the Durham House Drainage Company.

Soil-pipes should be four or five inches in diameter, the former size being sufficient for fixtures in the administration building and also for the wards, except where there is a very large number of fixtures on the line. In hospitals for insane, however, I prefer to use five-inch soil-pipes owing to the somewhat greater danger of the soil-pipes becoming stopped up by a wrongful use of the water-closets. Waste-pipes are made either two or three inches in diameter, this depending upon the character and number of fixtures placed on the line. Slop-sinks, for instance, require three-inch waste-pipes. Hospital bath-tubs and spray-baths require larger waste-pipes than used in private houses in order to empty quickly.

As regards the inclination to be given to the house sewers and horizontal waste-pipes, one-quarter of an inch is the minimum fall permissible. I prefer to give to four-inch lines a fall of one-half inch to the foot, and smaller waste-pipes should have an even greater fall.

Connections of branch waste-pipes with the main vertical lines are made with Y-branches or else with T-Y branches, but the latter fittings should not be used in horizontal lines. Lead pipe should only be used for the water-closet connections and for short waste-pipes. In connecting the same with iron pipes, drawn brass ferrules or screw nipples should be used, which must be bell-shaped and extra heavy.

Brass floor-plates should always be used for porcelain water-closets having the trap above the floor, in order to insure a tight floor joint.

Where brass pipe is used for waste- or vent-pipe, it should be seamless drawn brass tubing of iron pipe gauge, and all connections should be screwed joints. No slip or coupling should be permitted on waste- or vent-pipes.

Clean-outs should be placed in sufficient number on the line of the drains and at junctions, bends, and traps, and made accessible. They should be closed with extra heavy brass screw-caps, with thick flanges, and with strong square or hexagon nuts. To insure a tight joint, there should be at least six engaging threads.

Roof joints should be made with copper or sheet-lead flashings. In case some of the rain-water conductors are connected for special reasons with the sewer system, they must be properly trapped. Inside leaders should be of extra heavy cast iron or else of heavy screw-jointed wrought-iron pipe; outside leaders may consist of sheet metal.

No trap should be placed at the foot of any vertical line of soil or waste-pipe. All such lines should be fully ventilated by extensions through the roof. Where back-air pipes are used, I prefer extending them to the roofs separately.

The pipes on the roofs should remain fully exposed, and vent caps or return bends and cowls should not be used. Pipes should be kept away from dormer windows, also from flues and ventilating skylights. Pipes coming through lower roofs of extensions must be extended to the main and higher roof whenever they open too close to windows.

All vertical vent lines should be dripped at the bottom of the line and care should be taken, where traps are backaired, to enter the branch vent into the main line above the overflow point of the fixture, so that the vent cannot act as waste when the latter should become stopped up.

Mason's traps, D-traps, bell-traps, pot-, drum-, or bottle-traps should not be used; likewise should mechanical traps, with flap-valves, gravity balls, rubber floating balls, mercury seals, etc., be avoided. Traps having interior dividing partitions forming the trap-seal are objectionable as being liable to have sandholes in the cast partitions, which would render the seal inefficient.

All traps should have trap or cleaning-screws, which must be arranged so as to be below the water-line in the trap, for if on the sewer side of the trap-seal, they may leak sewer air when not tightly closed. Lead traps should be extra heavy and of the same weight as lead waste-pipes. Brass traps must be of iron pipe size and should be manufactured perfectly smooth on the inside, for roughness of the interior of a trap tends to stoppages.

Every fixture should be trapped separately.

The sizes of traps for fixtures should be as follows: for water-closets 3½ or 4 inches, for slop-sinks, shower- and needle-baths, and floor drains 3 inches, for kitchen and other large sinks and for wash-tubs and spray-baths, 2 inches, for pantry and small sinks, for wash-basins, etc., 1½ inches. Bath-tubs should have 1½ or

2-inch traps, the latter emptying the fixture more rapidly. Urinals are usually trapped by 2-inch traps, though 1½ inches would seem to be ample in all cases. Traps located under the cellar floor should be made accessible by manholes.

In toilet-rooms floor drains are often desirable, and if used should be very securely trapped. Wherever possible, floor drains should not be connected with the sewer system. They, as well as cellar floor drains, may connect with the land drains.

No exhaust steam or steam-pipe should be connected with a sewer or soil-pipe, but they should discharge into a condensing and blow-off tank, with outlet-pipe connected to the sewer outside the house-trap.

Pan-, valve-, and plunger-closets should never be used. All water-closet bowls should have flushing rims. Water-closets having traps located below the floor, should have either heavy lead traps or else iron traps which must be enameled on the inside. Overflow pipes of water-closet cisterns should discharge into the water-closet bowl. Overflow-pipes of other fixtures should connect with the waste-pipes on the house side of the trap, or else below the water line.

Local vent-pipes for plumbing fixtures complicate the arrangement and are not necessary where a good ventilation of the room has been otherwise arranged for.

Water-pipes for plumbing fixtures should never be run on outside walls or in exposed places where they would be liable to freeze.

A final correct plan of the sewer- and drain-pipe system, as constructed, should be drawn and kept on file for reference, or else all changes made during construction should be noted on the original plans of the work.

All plumbing systems should be tested, first, by the water-pressure test when the "rough" work is in place, including the water-closet branches and the branches to fixtures; second, by a smoke test when the water has been turned on at all the pipes and fixtures.

6. Subdivision of Hospital Buildings.—In every kind of hospital there are certain sub-divisions, which in the case of the larger and most completely fitted institutions are generally located in separate buildings. The sub-divisions comprise: first, the hospital wards with their adjoining service-rooms, such as baths, lavatories, water-closets, broom-closets, and rooms for the nurses in charge of the wards; the administration building with rooms and offices for the superintendent, the steward, and the medical staff; the nurses' sleeping apartments, toilet and bath-rooms, and nurses' dining-rooms; the matron's quarters; the operating-rooms with rooms for the appurtenances belonging thereto; the drug store or dispensary; the working department of the hospital, consisting of kitchen, scullery, pantries, and serving-rooms, and dining-rooms for the help; the bakery and laundry; rooms for male and female help; the boiler- and engine-room, the dynamo- and pump-rooms, the disinfecting-room or station, the mortuary, ice-house and garbage crematory, and sometimes a stable. All these departments must be fitted up with more or less plumbing and drainage appliances. In the following each of these will be briefly considered.

7. Water-closet Rooms and Fixtures for Hospital Wards.—The room containing the ward water-closets should be placed convenient to the ward, but not immediately adjoining the same. It should be a room by itself and should not contain the lavatories or the baths. It should contain only the water-closets, the urinals, and the slop-sinks. It is better to provide separate water-closets for nurses and attendants.

The number of closets to be provided for a ward depends upon the size of the ward. It is usual to estimate one closet for each 10 patients, though this number may be slightly varied in the case of insane patients, and on the women's side of the hospital.

To promote cleanliness, all parts of the toilet-room should be amply lighted, and structural materials should be used for the walls, floors, ceilings, partitions, and fixtures which are non-absorptive and permit of easy cleaning. All sharp corners, mouldings and cornices which harbor dirt and dust should be done away with. Woodwork is very absorbent and should not be used at all for the wainscoting of the room, or for partitions. Common plaster, paint, and varnish also absorb organic impurities and cannot be approved.

The floor should be tiled with unglazed encaustic tiles, or with large slabs of marble or slate; mosaic tile floors may also be used. The floor is sometimes arranged so as to pitch to one point, and a floor cesspool and drain is provided, so as to permit the washing of the entire room with a hose.

The walls to a height of at least six or seven feet should be lined with glazed tiles, or still better, with large slabs of marble, slate or soapstone. The ceiling is either arched with brick arches or made of sheet metal painted with enamel paint. The partitions between the fixtures should also be of marble, slate, or of opaque glass. The suggestion to used hammered or annealed glass for wall linings or partitions dates back from 1875, but they have only recently been manufactured and used. It is preferable not to have the partitions reach to the floor, but to raise them about eight or ten inches, because this facilitates the cleaning of the floor. In the same way, it is better not to extend the partitions to the rear wall, but to stop the same about two inches from the wall, so as to be able to reach behind, also to avoid the sharp corners between partitions and wall slabs, which easily accumulate dirt and are difficult to keep clean.

Sharp corners should also be avoided between the wall lining and the floor, by rounding off the corners or using special round mouldings of tile or marble. In the case of hospitals for insane, it is usual to omit the partitions between the seats. The closet doors are also often omitted where control of the patients is necessary. Where doors are used, they should be short, light flap doors not reaching to the floor, and preferably hinged so that they will stand open, except when the seat is occupied.

Water-closet fixtures, to be suitable for hospitals, should be of white earthenware, or where greater strength is required or a rough usage is expected, as in the case of hospitals for the insane, they should be made of heavy glazed fire-clay or stoneware. Iron water-closets are not serviceable in the long run; the plain iron closets never look clean and the enameled-iron bowls, though somewhat better, soon lose the enamel lining by chipping and then they rust rapidly. The only suitable and sanitary types are the pedestal wash-down and the siphon-jet closets, but the latter are more liable to stoppage and are therefore also unsuitable, especially so for closets to be used for insane patients. All ornamentation of the closet bowl is of course entirely out of question in a hospital. Only the plain white fixtures should be used. The only woodwork should be the seat, which must not be a full seat but an open round hardwood polished seat, attached to the rear of the closet bowl by hinges, so that it may be turned up to expose the bowl for cleaning. For the sake of cleanliness a form of water-closet bowl offers advantages for hospitals, in which the front of the wooden seat is cut out, and a vertical projection formed in the front part of the top of bowl, which acts also as a urine shield, and prevents the latter from being spilled over at the front of the closet. Of late years a modified type of closet has been used to some extent in hospitals for insane, which dispenses with the wooden seat, the top of the bowl being formed in porcelain to serve as the seat. In the case of filthy insane patients these closets offer certain advantages. For quiet and clean patients I cannot see any objection to a plain wooden seat, if the latter is strongly framed and otherwise well made, so as not to crack or warp. The objections to an all-porcelain seat are that it is cold; that no seat attachment can de used and therefore an automatic flush must be arranged which is somewhat wasteful of water; and there is the further important objection that the inside of the upper part of the closet bowl cannot be readily examined and cleaned.

For general hospitals, the flushing arrangement for the closet may consist of the well-known chain and pull arrangement; for some of the insane patients it is better to use an automatic seat attachment flush in combination with either an open or a closed pressure-tank, or else a combination automatic and pull-tank may be used, for in the quieter wards it is found that patients do make use of the pull. The flushing-cisterns should be copper-lined wooden tanks, as iron tanks rust aud stain the closet bowl, also because they sweat in summer time and cause drippings from the tank to the floor. The flush-pipe, should be large, at least 1¼ inches inside diameter, of lead, of brass, or of polished and rustless steel. Lead should not be used in hospitals for insane, as it is too easily dented, cut, or flattened. Brass flush-pipes may be polished and lacquered, or else they are finished in dark bronze or have a bluish steel finish; they also look well if silver bronzed or painted with enamel paint.

Urinals should be avoided as much as possible, and generally the water-closet fixture may take their place. If required, urinals for wards should be porcelain fixtures holding water in the bowl, fastened to the marble wall lining, and provided with automatic flush-tank. If a marble floor slab is used, it should not have a waste, for this becomes foul from the drippings of the urine. In some general hospitals, bidets are installed on the women's side, and if provided with a flush, they may answer as urinettes; for insane patients such fixtures are not to be recommended.

A slop-sink may properly be placed in the water-closet room, for it is a fixture intended to receive the foul discharges from bed-pans, chambers, glass urinals, commodes and other sick-room utensils, and used for the rinsing and washing of these fixtures. It must therefore be treated much like a water-closet, and should always be of a type with flushing-rim and provided with flushing-cistern. Hot and cold water faucets should also be provided, and sometimes an upward jet is added for the rinsing of bed-pans, etc.

All fixtures in ward toilet-rooms should be selected with a view of accomplishing the most complete and rapid removal of all dejecta and fouled liquid wastes. Perfect flushing arrangements and an ample supply of water for flushing purposes are required. Proper provision should likewise be made for a perfect ventilation of the apartment, and under no circumstances should any movement of air take place from the toilet-room towards the wards.

8. Bath-rooms for Hospital Wards.—Ward bath-rooms should be in convenient reach of the ward, but disconnected from it by a corridor, so as to exclude and cut off any steam vapors. The bath-rooms for patients should be separate from those for the nurses and attendants. The room should have plenty of light, and windows should have frosted, opaque or frilled glass. The best floor is a solid floor, made by using I-beams and brick arches. These may be covered either with concrete and cement, or with asphalt, so as to be waterproof. A nicer effect and appearance are gained by adopting a mosaic tile floor, or finishing the floor with large slabs of marble, or finally by using small vitreous tiles. Glazed tiles should never be used in a bath-room as they render the floor too slippery. A novel floor finish consists in a rubber interlocked tile floor, which is durable, warm to the feet, soft to walk upon, and perfectly sanitary, though somewhat more expensive than a tile floor.

The walls of the bath-room should be finished with a waterproof and non-absorbent material, such as enameled brick, slate, or marble, to a height of at least 6 feet. Such a room can be kept pure and clean by turning on a stream from a hose and washing the entire sides. As the ceiling is exposed to vapors of steam it should also be solid, either finished in hard plaster and painted with oil or enamel paint, or else the same should be constructed with sheet metal. The door leading to the bath-room should be made large to admit a patient carried on a stretcher. The bath-room should be well-ventilated and must be well heated. In some hospitals this is efficiently accomplished by heating the floor of the room.

The number of bath-tubs to be provided depends upon the number of patients in the ward; it is usual to calculate one tub for each fifteen patients; where two tubs are necessary, one should be a hospital tub, set on rubber-bound wheels, so as to be movable; it should not be fixedly connected to the plumbing pipes. The floor of the room should be given a good pitch to one point where a floor drain should be placed. The hospital tub is emptied at this point, and large hot and cold-water mixing-cocks should be provided for quickly filling the tub.

The fixed bath-tub should stand free on all sides from the wall, so as to enable the nurses to reach the patient conveniently from any point. The tubs may be strong sheet-metal tubs standing free on legs and not having the usual wooden casing; or they may be porcelain-lined iron tubs; or the more expensive, heavier porcelain tubs with roll rim. As a rule, enameled iron answers well enough as a material for tubs if care is only exercised in the use of the tub. The enamel is somewhat apt to chip off or to crack, where anything heavy is allowed to drop into the tub. To avoid the diffusion of steam-vapor in the room, mixing faucets for hot and cold water are used. In hospitals for insane patients, the supply-valves should be always out of reach of the patients to avoid accidents or intended suicide by scalding, or else key-valves should be used.

Of late years, a much more effective, clean, and economical method of bathing the insane has been introduced, by means of rain- or spray-baths. In the state hospitals of New York State such spray-baths are obligatory, and tubs for patients are entirely abolished. The advantages of this new method have been universally admitted and the old tubs are everywhere being replaced by the simpler and better spray-baths. In some cases a congregate bath-room is fitted up, which enables the simultaneous bathing of a large number of patients. A good example, and the first one of a large bath-house for insane, may be seen at the Utica State Hospital, which was designed and installed by the writer. Another similar bath-house has been constructed under the writer's plans, specifications, and supervision, at the Long Island State Hospital at Kings Park. In many of the other hospitals each ward is provided with one or two spray-baths. The apparatus is very simple, consisting of an overhead inclined douche or nozzle, supplied with mixed water at a temperature not exceeding 100 degrees Fahrenheit. Special mixing chambers for hot and cold water are used, or else a new appliance, called a "Gegenstrom" apparatus, in which steam and water pass in opposite directions, the water being heated as it flows. This does away entirely with hot-water tanks and mixing-chambers.*

Large city hospitals are sometimes provided with a bath-house in a separate building, wherein all kinds of medicated and special baths are put up, including sometimes Russian and Turkish baths, cabinet-vapor baths, baths for hydrotherapeutic treatments, electrical baths, sun baths, sitz and foot baths, bidets, etc. For the treatment of skin diseases and of certain ailments like typhoid fever, etc., European hospitals are provided with so-called "permanent water-baths." In all bath-rooms and bath-houses special provision should be made for warming the change of linen for the patients.

9. Lavatories for Hospital Wards.—A separate room adjoining the ward should contain the lavatories for

* See the author's pamphlets on "The Modern Rain-bath," and his book "Modern Baths and Bath Houses."

the patients. This room should be finished in much the same manner as the bath-room, and it should contain one wash-basin for about eight or ten patients. In addition, a small shallow porcelain housemaid's sink is often put in this room for drawing hot or cold water. To discuss the type of basin best adapted for hospitals would lead me too far; I will only mention that all wash-basins with secret waste-valves and hidden overflow-pipes should be avoided. The entire arrangement should be open and unenclosed; there should be no cupboards and no wooden enclosures. The modern all-porcelain lavatories are particularly adapted for use in hospital wards, as they have no plaster-of-Paris joints between the bowl and the marble slab. All basins should be quick-emptying and should have hot as well as cold water faucets. It is important that each basin should be separately trapped. In lavatories for insane patients, the hot-water faucets should have detachable key handles.

10. Nurses' Toilet-rooms.—It is desirable that separate bath, lavatory, and water-closet accommodations be provided for the hospital nurses. While the basins and the bath-tub may be put in one room, a separate apartment should contain the water-closet. The details of these appliances do not call for special discussion, for they do not differ essentially from those used in private houses. For water-closets I recommend the type known as the pedestal short hopper or wash-down closets, with polished hardwood seats and with cisterns operated by chain and pull. The trap should be of earthenware, in one piece with the bowl, and should have about 3 inches of water-seal. The bath-room should contain a tub and a spray-bath.

In larger general hospitals, and also in the hospitals for the insane, a separate building is often provided for the nurses, containing not only bedrooms, but also sitting-rooms and reading-rooms for the nurses, a lecture room for the nurses of the Training School, as well as toilet-rooms.

11. Bath-rooms for the Officers and Medical Staff.—In the administration building, provision should be made for toilet-rooms for the executive officers, for clerks, and for the medical staff. Likewise should bath-rooms be attached to the living rooms of the resident physician or the superintendent. The plumbing work for these should be of the same character as provided for in private houses. I can therefore safely pass these over, except that I wish to plead once more for the separation of the water-closet and the bath-room, and this for reasons which I have often set forth, and which should be apparent to all thoughtful persons. The water-closet most adapted for use in private bath-rooms is the modern siphon-jet closet, with deep trap-seal and with open seat attached to the bowl, and without back-piece or panel-board.

12. Operating Rooms.—Every hospital has either one or several operating rooms, and the larger clinical hospitals are generally provided with operating theatres, which are fitted up with all modern requirements of aseptic surgery, and also contain more or less plumbing work. It is self-evident that the operating-rooms are of particular importance and require the very best and safest plumbing work, in order to avoid the danger of blood-poisoning or contagion.

All parts of an operating-room should be so constructed and fitted up as to be readily cleaned and made aseptic. There should be plenty of light, perfect ventilation, and abundant facilities for washing and flushing. All instruments, bandages, utensils, and vessels must be made germ-proof or sterilized. Sterilized water should be available for the operating surgeon to wash his hands with. All tables and furniture, like stretchers, operating-tables, instrument cabinet cases, immersion bowls and tables and other accessories should consist of white enameled wrought-iron frames and polished glass tops. The floor of the room should be tiled and provided with a floor drain for washing the floor. The walls and even the doors are often lined with large slabs of marble, slate, or Alberene stone; enameled face brick is often used for the walls from floor to ceiling.

No soil- or waste-pipes connected with the hospital sewer should pass through the operating rooms. The plumbing fixtures located in the rooms should be disconnected, i.e., should discharge with open mouth over a trapped basement or cellar sink provided with faucet. The highest character of workmanship is required at the fixtures in the operating-room. There should be porcelain sinks with glazed roll-rims, and without woodwork of any kind. Drain-boards, if any are required, should be of slate, Alberene stone, or glass. The best sanitary wash-stand fixtures should be used.

Modern hospital wash-stands, which consist of glass bowls fitted up in connection with glass slabs, are now purchasable. These are generally fitted up with self-closing pedal supply-valves, in connection with a nozzle, giving either hot, cold, or mixed water. Sometimes the basin waste-valve is similarly operated by a foot action. Pressure sterilizing apparatus for water must be provided, generally one for hot and another for cold water, likewise sterilizers for surgical dressings, bandages, and for surgical instruments and appliances, also buckets to receive the waste dressings, which are to be burned. While these are not strictly belonging to plumbing work, they require water and gas-pipe connections, drip-pipes, and also steam connections. In a convenient location near the operating-rooms there should be toilet-rooms, where surgeons and attendants can put on their operating suits and where they find for use wash-basins, water-closets, urinals, and a spray-bath.

13. **The Hospital Kitchen.**—In large hospitals, the kitchen is always located in a separate building. In smaller institutions it is placed either in the basement or on the ground floor of a wing of the building. In a few cases the kitchen is placed on or near the top floor, the idea being to prevent cooking odors from pervading the other parts of the hospital.

The hospital kitchen should be light, airy, and well ventilated. Floors and walls should be finished in non-absorbing, easily cleaned materials. The floor should be drained to one or several floor cesspools. A sufficient number of kitchen sinks of ample size should be provided, to draw water for the cooking operations and also for the cleaning, rinsing, and scouring of pots, kettles, and pans. The most durable sinks for use in the kitchen of an institution are cast-iron sinks; those of plain iron, painted on the outside, are undoubtedly the most serviceable, although not so cleanly looking as enameled or porcelain sinks. With the rough usage which these fixtures unavoidably undergo, the enameled iron would soon chip off or crack. Porcelain sinks, with roll-rims, are likewise liable to be damaged. In many institutions wooden sinks are used; for a few months they will be serviceable, but they soon rot and become foul looking and smelling, and I fail to see any real merit in them other than that of cheapness. Sinks generally require drain-boards, which likewise should not be of wood. I have found slabs of slate or of Alberene stone to be durable and serviceable.

The kitchen ranges should be proportioned to the number of people for which cooking is to be done. In some cases this and other cooking apparatus are fitted up by the plumbers, but as a rule they are installed by firms making a specialty of such work. Even then the numerous appliances, such as steam-jacketed boiling vessels for making soup, boiling meat, vegetables or puddings; the tea and coffee copper urns; the gas or steam ovens, roasters and broilers will require water connections, drip-pipes for the drip-pans, and sometimes gas connections. Steam carving and serving tables are also placed in the kitchen unless the pantry is very large, when they are sometimes located in the latter by preference. Inasmuch as the population of a hospital is liable to vary considerably, it is better to provide all the kitchen outfit in duplicate, so as to have facilities for cooking economically for a smaller number of persons. Adjoining the kitchen there should be a roomy store-room for the kitchen supplies.

14. **The Scullery.**—It is better to sub-divide the various kitchen operations in such a way that they may be carried out in adjoining rooms. Where the building permits this, it is well to have a scullery adjoining the kitchen, in which the preparing of the vegetables, the washing of potatoes, and salads, of meats and fruits, etc., may be done, and also the washing of the plates and dishes. Plenty of sinks should be arranged and each provided with hot and cold water and with drain-board. In some modern institutions the washing of the dishes is done in large dish-washing machines, which, although quite expensive, effect a considerable saving in manual labor. These and the sinks should be provided by the plumber with a large grease trap. I recommend to locate the grease trap outside of the building, because it has to be frequently cleaned, and this operation is by no means a pleasant one. The general finish of a scullery should be similar to that of the kitchen.

15. **The Pantry.**—A pantry is always planned near or immediately adjoining the dining-room. It should contain sinks for the washing of the finer dishes, of the glasses, cups, and saucers from the dining table. While porcelain or slate sinks are cleanly and sanitary, they are hardly suitable for a hospital pantry, where owing to the carelessness of servants too many dishes

and glasses would be broken in them. Copper sinks are probably best adapted for the purpose, although the evil of breaking porcelain and glass is somewhat mitigated where rubber mats are used in porcelain sinks. Owing to the greasy nature of the dish-water, it is often necessary to use a grease trap in connection with the sinks. Hot plate warmers are also put in the pantry, likewise germ-proof filters for the drinking-water used at the table, and occasionally small portable refrigerators for butter, jellies, and smaller articles of food. It is important that the refrigerator should not be directly in connection with any soil-pipe or sewer. It should always be thoroughly disconnected and have an open waste or discharge over a trapped and water-supplied sink.

16. The Hospital Bakery.—In large hospitals the bakery is placed in a separate building, while in smaller institutions the baking is done in a basement room near the kitchen. Here bread and pastry are prepared, and the operations generally require several rooms, namely, a room for the mixing and kneading of the dough and making of the loafs; a room for the bake ovens; a store room for the flour and another for the finished products.

The plumbing work is generally very simple in character. A sink for drawing water is required, also troughs of wood, or better of slate, for the preparation of the dough. In a few hospitals dough-kneading machines driven by steam-power are in use. The bake-ovens are heated either with coal, gas, or hot water.

17. Refrigerator Room and Ice House.—Large hospitals require cold-storage rooms for meat and fish, for butter, and other supplies. These should be arranged in every way sanitary, and in view of the fact that meat readily becomes tainted and that milk absorbs impurities, the greatest care should be exercised in the drainage arrangements of refrigerating rooms. No direct connection with any foul water sewer should be tolerated.

Hospitals require large quantities of ice for various purposes, and where no refrigerating plant is installed, an ice house will be a desirable feature. Much attention should be given to the source of the ice supply to avoid the dangers of impure ice. The drainage of the ice house requires great care, and should any sewers necessarily pass near by, it will be necessary to take special precautions to avoid any leakage of sewage towards the ice house.

18. The Hospital Laundry.—The laundry is a very important adjunct of the hospital. A location for the same separated from the wards and the main building is always desirable to avoid the annoyance from steam vapors permeating the building. As a rule, it is desirable to place the laundry in a separate building. This should be a roomy structure, providing ample space for the laundry operations. The building usually requires several subdivisions. There should be a room for the soiled clothes, a large wash-house, a drying-room, an ironing-room, and a room for the storage and assortment of the clean linen, in which room sewing and mending may also be done. Sometimes a separate small laundry is provided for the washing of the officer's linen. A disinfecting and fumigating room for the soiled linen and bedding of infectious disease patients should be a part of every complete hospital laundry.

A laundry requires a good deal of plumbing, and also laundry machinery, for which steam and water supplies and wastes must be arranged. The wash-room proper contains the wash-tubs, the number of these depending upon the population of the hospital. Wash-tubs, which formerly were of wood, are now obtainable at reasonable prices in white and yellow stoneware with roll-rims, thus doing away with wooden frames or tops which are an abomination and never last beyond a few months. The tubs should be properly trapped and connected with separate Y-branches to the line of the drain-pipe. Hot and cold water-pipes should be provided of ample size to supply all the faucets of a row of tubs if running simultaneously. Washing-machines are not usually connected with the drains, but discharge over open concrete gutters, with trapped outlets to the drainage system. Sometimes the room contains rinsing machines, steam-boiling kettles, soap kettles, etc. Centrifugal dryers or wringers are provided, which must have trapped floor connections to remove the drippings from the wash.

The remaining outfit of a steam laundry consists of drying-rooms with horses, steam mangles, and special ironing machines for shirts, collars, and cuffs, starch kettles, an engine to drive the shafting for all machinery, and stoves for heating the irons, all of which require steam and gas connections. A laundry is often the place where a fire starts in a hospital, and it may be wise to guard further against this calamity by providing not only fire stand-pipes with fire-valves and fire-hose, but also a complete automatic sprinkler system, requiring roof tanks, piping, valves, and sprinkler heads.

19. **The Boiler-house.**—The hospital boiler-house, containing the steam-heating and power-boilers, the coal vaults, the boiler-feed, house, and fire pumps, sometimes a suction tank, the dynamos and engines and switchboard, will require a good deal of plumbing work, in connection with the supply- and discharge-piping and necessary cross-connections of the pumps. Sometimes the general hot-water tank for the institution is placed in this building. There should also be a small engineer's toilet-room, with water-closet, wash-basin and sink, and a spray-bath for the firemen.

20. **The Drug Store and Dispensary.**—Every hospital requires a drug store, and often it has a public dispensary. This department should be fitted up with one or more sinks for washing of bottles and for drawing water; sometimes a separate wash-basin is fitted up. There may also be a pressure-filter to obtain pure water. Adjoining the waiting-room of the dispensary there should be separate public toilet-rooms for men and women.

21. **Water-closets for Employees.**—For the large number of employees, constituting the male and female help in the working departments of a hospital, suitable toilet-room accommodations must be provided. These do not require a special description, but I may here

remark with regard to the plumbing of servants' water-closets and also the general plumbing in the kitchen, scullery, pantry, bakery, laundry, and boiler-house, that there seems to be a general and very erroneous impression prevailing that anything in the way of plumbing will answer the purpose, provided that there is a water supply and a waste connection, and that the separate trapping of fixtures would here be an ultra-refinement and vent-pipes to the roof an unnecessary expense. I have found in my examinations of public institutions a great deal of defective and slovenly plumbing work in the working department of hospitals, much lack of cleanliness, and a great indifference on the part of those in charge of the same.

These departments of a hospital require the same correctness in planning, careful execution of the work, and good substantial fixtures as the bath-rooms and toilet-rooms for the patients and officers. The rooms where the food supply is prepared should be free from any possible sewer air contamination, not only to guard against the food becoming contaminated, but also to protect the health of the kitchen and laundry employees.

22. **The Mortuary or Deadhouse.**—Large hospitals always have a small separate deadhouse, where patients who died are kept pending burial or a post-mortem examination. The principal room should be finished entirely with non-absorbent materials, so that it may be washed from time to time by means of a hose. The floor should be tiled and provided with floor drains and sewer connection. There should be a porcelain

roll-rim sink with hot and cold water. For anatomical dissecting there should be a slate, marble or glass slab or a post-mortem table arranged to revolve, with a waste connection and with overhead supplies, to which rubber hose may be attached.

23. The Disinfecting Station.—Modern hospitals are also provided with a disinfecting station which is generally in a separate and detached building. This may serve not only the purpose of disinfecting the linen and clothes of infected patients before they are received in the hospital, but also for the disinfection of soiled articles before washing, of bed mattresses and other bedroom furniture by means of either steam or formaldehyde. Generally, the disinfecting station is provided with a bath-room having a spray-bath for the use of the attendants. This building is an important adjunct of every hospital for infectious diseases. Usually the disinfecting room is divided by a solid partition into two parts, in one of which the things to be disinfected are placed in the apparatus, while they are taken out at the opposite end in the adjoining room. Every hospital should have a portable disinfecting apparatus for safely generating large volumes of formaldehyde gas which may be used in the disinfection of the hospital wards, or for ward utensils and bedding, or for disinfecting excreta and other wastes.

24. Garbage Disposal.—Large hospitals should have a garbage furnace or cremator for the destruction, by fire, of the garbage and solid waste matters, of the infected surgical bandages, dressings, and of the other numerous refuse of the institution. This garbage cremator may advantageously be erected in the boiler-house or immediately adjoining the same.

25. Sewage Disinfection.—In infectious disease hospitals, provision should be made for the disinfection of the excreta of typhoid fever and cholera patients. This is also advisable in the case of the sputum of patients suffering with phthisis. The disinfection may be accomplished by means of steam under pressure with the addition of chemicals, such as permanganate of potash. In some of the European hospitals, the water-closet fixtures for infectious patients are arranged with steam connection so that an immediate disinfection of the excreta may be carried out in these fixtures. All such arrangements require special treatment, but a detailed description would lead us too far.

26. Hot-water Supply.—Hot water is required in a hospital in great abundance. As a rule this is obtained from closed round steel or boiler iron tanks, in which a brass or copper steam coil is placed, which serves to heat the water. It is desirable to maintain an even temperature of the tank water, and this may be accomplished by the use of the thermostats or temperature regulators. A somewhat different hot-water generating device is the Tobey heater, which has been used to some extent in large hospitals, and which consists of a large horizontal heater, with automatic steam-valve, regulated and operated by an expansion rod located in the upper part of the heater. This device prevents the overheating of the water and thus tends to economize in fuel. It also enables the control of the temperature of the hot water, as the valve may be set to give water at any desired temperature, and thus avoids to a great extent the danger of scalding which is ever-present where the hot water may become overheated.

It is desirable in a large building to furnish hot water at various degrees of heat, therefore several heaters should be provided, one intended to furnish water for the baths and lavatories, in which the temperature need not exceed 130 degrees F., the other to furnish hot water for dish-washing and kitchen purposes, which may be required at a temperature of about 180 degrees F. For the spray-baths, the "Gegenstrom" apparatus has proven very successful, and not the least advantage of the same is the fact that it renders special hot-water tanks entirely unnecessary, as it heats water by steam directly and almost instantaneously. There are other instantaneous water heaters, using gas as fuel, which in some places in a hospital may prove efficient and serviceable.

27. Water Supply for Fire Protection Purposes.—No hospital building should be left without fire protection and fire-extinguishing appliances. There should be lines of fire stand-pipes in all buildings, with fire-valves and fire-hose on every floor. These may be supplied either from the elevated roof tanks, or from a special fire-pump in the boiler-house. A number of fire-pails should also be provided and set on shelves along the corridors and in unimportant rooms. A number of non-freezing fire-hydrants should be placed in the hospital grounds, and the necessary lengths of rubber-lined fire hose should be kept in readiness in the engineer's department, or better in a special fire-engine house, with hose-tower in which the hose after practice fire-drills may be hung up vertically to dry.*

Conclusion.—In a well-managed hospital the most thorough cleanliness and a pure condition of the air indoors are secured by a constant vigilance against all manner of dirt. Half the battle is won where the buildings have a good system of sewerage and plumbing. These will not only prevent a contamination of the atmosphere in the toilet-rooms, lavatories, and sick wards by emanations from the sewer-pipes and plumbing fixtures, but they will also render it impossible for the soil upon which the building stands to become polluted and give off gases injurious to health and fatal to disease. They will, finally, assist in the maintenance of absolute cleanliness of the walls and floors, of personal cleanliness, and purity of the water and food supply of a hospital.

Note.—During a recent vacation spent in traveling in Europe, the author visited a large number of modern hospitals, and found these to compare most favorably with similar buildings in this country. Among the more important ones inspected I mention the Hamburg-Eppendorf General Hospital, the Heil-Anstalt Beelitz near Berlin, the Hospital for Insane at Doesen near Leipsic, the Johannstadt Hospital in Dresden, the new Municipal Hospital of Nuremberg, and finally, the Elizabeth Hospital of Aix-la-Chapelle. Of many of these the author was fortunate enough to secure plans and interior views. To those in search of the latest

* See Appendix A.

practical information regarding hospital planning and equipment, a visit to all of them is recommended, and especially to the latest examples of hospital construction at Beelitz near Berlin, and at Nuremberg. The new bath-house of the Elizabeth Hospital at Aix-la-Chapelle, while not very large, is a model particularly worth seeing.

The tendency in Europe has for some time been, and seems to be at present, to avoid absolutely any monumental buildings of many stories, but to erect instead buildings of one or two stories on the pavilion plan, which would be capable of being easily replaced by new structures in case of necessity. The majority of large hospitals are so built and are located, not in the center of the city, but on the outskirts where the lesser cost of land enables the designer to spread out the buildings, thus achieving better sanitary results.

It was the author's intention at first to illustrate this chapter, but he refers those interested to the excellent catalogue of Hospital Fixtures, issued by the J. L. Mott Iron Works, in which are illustrated quite a number of special hospital features taken from the author's practice.

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THEATRE SANITATION

II

THEATRE SANITATION *

1. Unsanitary Conditions in Theatres.—Arrangements for the health and comfort of theatre-goers, of actors and of stage employees are seldom considered, except in rare instances of a few recent metropolitan theatres. Leaving these out of consideration, it is no exaggeration to state that most theatres are ill-ventilated and badly drained, that the arrangement of their toilet-

* The substance of the above chapter was presented by the author in a paper, read at the annual meeting of the American Public Health Association at Ottawa, Canada, September 27, 1893. The paper was introduced with the following words:

"The Honorable President of our Association has invited me to prepare a paper for its annual meeting, and seeing that the Executive Committee has placed among the topics for consideration 'Sanitation with special reference to Drainage, Plumbing, and Ventilation of Public Buildings,' I have selected as my subject 'The Hygiene of Theatres,' not so much with a view of presenting any new facts or startling theories, as with a view of eliciting discussion upon a question of sanitation which has been hitherto somewhat neglected.

"One reason for this apparent neglect is undoubtedly the fact that, though large numbers of persons are congregated in theatres, concert halls, and other places of amusement the duration of stay in such buildings is a brief one, never exceeding three or four hours at the most, whereas in other public buildings, such as schools, court-houses, assembly halls, and lecture halls, occupancy generally extends during the whole or a large part of each day. I venture to assert, however, that rooms is unsanitary and ill-planned, that the plumbing is defective, the water-closet accommodation inadequate, the dressing-rooms overcrowded and without any provision for comfort and fresh air, and that the general state of cleanliness of the building is far from being satisfactory.

It is a well-known fact that there are vast numbers of persons who, while they would thoroughly enjoy a good play, are restrained from visiting such places of amusement, for the very good reason that they fear the exposure to the stifling, noxious, overheated atmosphere of the buildings, and who are sure, if they do go, to awake the next morning with a severe headache or with a cold or sore throat, contracted through exposure to draughts. If this is true of the theatre-goers,

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going to see a play would be a far greater pleasure, if theatres were adequately ventilated and otherwise kept in a sanitary condition.

"My intention originally was to base the statements of this paper upon a careful detailed personal examination of existing theatre buildings, but pressure of business and the limited time afforded me for the preparation of this paper prevented me from making such special studies and inspections, and I am therefore obliged to draw largely from casual experience and observations taken while visiting both parts (i.e., before and behind the curtain) of a number of theatres.

"Doubtless, many of the points brought up in my paper, contain nothing new to the learned members of this association. I hope, however, that the paper will be the means of bringing about a free discussion, which will in the end surely result in benefit to the public, for there are hundreds of theatres and amusement halls in our cities and towns, the sanitary arrangements of which are utterly bad and require a thorough remodeling."

how much more must the performers and stage hands suffer, who are obliged to remain in the building, not only during the performance but also for rehearsals, and for the countless preparations incidental to the staging of a new play. The general state of health of performers must in consequence suffer and they are often subject to throat troubles or other ailments.

The arrangement of the stage dressing-rooms is at times frightful beyond description. Often they are located below the level of the stage, in narrow dark underground passages, without outside window or any other means of ventilation. Their size is reduced to a minimum and they are generally overcrowded. In many instances, the theatre architect has done his best to provide suitable dressing-rooms for a small company, and the place is subsequently changed to one devoted to comic opera or spectacular entertainments, requiring a larger number of performers. To accommodate these, the dressing-rooms are partitioned off, or dark underground places are selected for additional rooms. Then again, we find the water-closet accommodations, both for the public and for the actors and theatre employees, insufficient and always more or less antiquated, worn out, and defective, or lacking a sufficient water supply and flush. In many places their location and state of untidiness suggest the greatest disregard for decency and moral feeling.

One of the usual defects has reference to the site or location of a theatre, for the site frequently decides the location of the places from where the fresh air for the audience is taken. Many of the older theatres are located in the middle of a city block, with only one side fronting on the street. At the back or side of the building there is in some cases a small, dark, ill-aired court, obstructed by rubbish and accumulation of disused stage scenery, and which is frequently used as the only available urinal accommodation for the stage hands. How can it be possible to provide suitable inlets for *fresh air* for the audience in such courts where the air must be of necessity foul? Quite often, odors from neighboring restaurant kitchens or from stables extend to this court, and rush up to the stage whenever a door is opened. The isolation of the building, at least on three sides, is therefore very desirable not only for safety's sake, but to provide efficient ventilation.

In the understage we often find other sources for bad odors, such as defective or leaky sewer-pipes, untrapped floor cesspools and abominable pan-closets. The contaminated air will naturally rise to the stage, and rush into the auditorium whenever the curtain rises, or when the orchestra exit door to the understage is opened for a moment. I know of at least one theatre in Greater New York where each time the curtain rises a strong whiff of sewer air greets the audience.

The plan of a theatre building often is, of necessity, such that the auditorium has few, if any, windows to the outer air, which could be used for air-flushing at times when the house is not occupied. As a result of the shortcomings just mentioned, theatre audiences are obliged to breathe for several hours in succession, a noxious compound of the products of combustion due to gas illumination, and of the respiration and perspiration of hundreds of people, some of them doubtless in need of a thorough washing, while many are clothed in ill-smelling and dirty underclothes.

During a performance the atmosphere thus becomes stuffy and oppressive beyond description. It is stated upon good authority that chemical analyses show the air in the dress circle and gallery of many a theatre to be in the evening more foul than the air of street sewers. (See Appendix B.)

Behind the curtain, the worst forms of unsanitary conditions often exist. The stage floor is full of dust, which is but rarely thoroughly swept, and becomes stirred up by the constant shifting of scenery, by the rolling up of stage carpets, by the moving of furniture and set pieces, by the dancing, etc. In the auditorium the carpets, upholstery of the seats, and the box decorations and hangings become saturated with the vile odors, possibly causing sore throats to persons in the audience who are susceptible to such ailments. Plush seats and floor carpets in public places are recognized harbingers of dust and disease germs, such as those of tuberculosis.

The wonder is that the public will not abstain from going to those theatres, the sanitary conditions of which are notoriously and grossly bad. If they were to do this, it would set the managers thinking, and reforms in the matter of theatre sanitation would soon be begun, in the same way as improvements in the safety of such places of amusement were, to some extent, impelled by the fact that after a theatre fire disaster, the public kept away from buildings known to be unsafe or even veritable death-traps.*

Having briefly alluded to some of the usual defects, I will now speak of the hygienic requirements of theatres and suggest some remedies which would render such buildings sanitary and comfortable and would enable theatre-goers to derive a few hours of real enjoyment in which to thoroughly appreciate the play.

I am convinced of the fact that sanitary reforms will in the future be accomplished if the public will only demand them.

2. Drainage and Sewerage.—In arranging for the drainage and sewerage of a theatre building the general rules as to size, and material for the sewer lines, the grade to be given, the manner of making proper pipe joints, etc., should be followed. As a rule, the area covered by a theatre building is so large as to require at least two six-inch sewer connections. Proper attention should be paid to proportioning the sizes of the rain-water conductors which drain the roof surfaces over the stage and the auditorium, because these are at times very large.

All areas and courts should be properly paved, pitched, graded, and drained. A difficulty in the way of drainage often arises from the considerable depth to which that portion of the stage house, known as the "under stage," has to be carried. Owing to the requirements of stage traps and stage machinery, the level of the

* See the Author's work, "Theatres, their Safety from Fire and Panic, their Comfort and Healthfulness." Published by *Bates and Guild Co.*, Boston, Mass.

understage is frequently located below the level of the sewer in the street. Any subsoil water accumulating in the sump, must be removed by lifting it either by means of automatic cellar drainers, worked by water pressure, or by means of steam ejectors, or finally by electric centrifugal pumps. Often the entire sub-cellar is constructed perfectly water-tight, like the cellar of a warehouse situated below tide or subsoil water level. This not only keeps out the subsoil water and prevents dampness, which is undesirable for the stage house, as it would tend to ruin the stage flooring, the stage property, and the actors' and supers' costumes, but it also prevents ground air from rising upwards and thus tends to keep the air of the stage pure and wholesome.

3. **Plumbing.**—I do not exaggerate when I state that there are but very few theatres which have the plumbing properly arranged. In recently built theatres, in those cities where plumbing rules and regulations are enforced, we find, of course, soil-pipes and waste lines carried full size up to the roof, and fixtures separately trapped. Generally, however, the plumbing is of the plainest kind, without any attempt at elaboration. On the other hand, the plumbing of theatres and "opera houses" in smaller towns and villages exhibits often the worst defects imaginable. The entire work is too often carried out in a slip-shod manner, the water-closets of dressing-rooms being generally set on "dead ends" of drain lines, having no soil-pipe extension to the roof and often being a part of the dressing-room, partitioned off by only thin board partitions. Basins

and sinks are sometimes in direct connection with the sewer, traps being considered a superfluous and altogether too expensive refinement for such buildings. In dark corners disused closets or sinks are at times discovered. Drains are laid in a hap-hazard manner, often sloping the wrong way. Tile drains and cement pipes are used where extra heavy cast-iron sewer-pipes should be run; all manner of faulty joints are discovered and in many cases the sewage drips on to the floor and becomes a contributory cause of the annoying odors which so often greet the audience when the curtain rises. Pan closets and ill-flushed hopper-closets are still made use of, and the apartments in which they are arranged are found to be in an indescribably filthy condition. This being the case, it is not surprising that we should find, even in some of our larger cities, an advertisement printed on the theatre programmes, stating that "the 'Ne plus Ultra' or other well-known disinfectant is used in this theatre."

It goes without saying that the plumbing of theatres should be planned and arranged with the same care as that of other public buildings. There should be toilet-rooms for each tier in the auditorium, entirely separate retiring-rooms being provided for men and women. Sufficient accommodations should be provided in that part of the stage house which contains the dressing-rooms, for actors and actresses. In addition there should be in the basement well arranged and ventilated toilet-rooms for the stage hands, employees, and the supers. The office of the theatre manager often has a separate toilet-room, and there is, in larger houses, a toilet-room adjoining the star's dressing-room. Near the engine- and pump-room a toilet-room for the engineer and his help should be provided, and if there is in the front part of the house a smoking-room or a refreshment room, a men's toilet-room is arranged with urinals and lavatories.

Handsome nickel-plated work and fittings do not seem called for in a theatre, except possibly in the toilet-rooms of the parquet and dress circle, or for the occupiers of the boxes in large opera houses, but nevertheless the entire arrangement should be in every way sanitary and the best workmanship is required. Woodwork should be avoided for well-known reasons. The floors and walls should be rendered water-proof and non-absorbent, partitions between water-closets and urinal stalls should consist of marble, slate, or soapstone. Every toilet-room should have a window to the outer air, and in addition artificial ventilation by exhaust flues should be provided.

The closets should be of glazed earthen or vitreous ware which will not craze. The type known as "washdown" closet is particularly adapted for a theatre, and the flush for the same should always come from a special copper-lined flushing cistern with pull flush. In some instances an automatic seat flush may be preferable, owing to the careless manner in which the public, as well as the stage hands, use such places.

For the same reason it may be preferable to have porcelain urinal bowls with self-acting intermittent flush-tanks. In theatres in which spectacular plays or ballets are performed, requiring a large number of female supers and dancers, self-flushing urinettes or pedestal urinals for women may with advantage be provided, as the same require for connection to the sewer a two-inch waste line, whereas the water-closet, ordinarily used by women as a urinal, requires a four-inch soil-pipe.

All stage dressing-rooms should be fitted up with small corner or wall lavatories, which must have both hot- and cold-water faucets. Each of these should be safely trapped, while the waste line should be extended to the roof for ventilation.

I have, on different occasions, pointed out the sanitary advantages of bathing facilities in general, and of the modern rain-bath in particular. I trust I may be in accord with the views of other sanitary advisers when I suggest that there should be in every theatre one or more douche or rain-baths for the use of actors and of the stage employees. A simple, inexpensive, waterproof stall of Alberene stone, or of slate, can be fitted up with a mixing valve for hot and cold water and with an overhead inclined douche. This does not occupy much space nor does it cost much to operate, because hot water is usually available. I am certain that it would be well patronized after the close of the performance.

There should be provided a few slop-sinks, both near the stage and in the public toilet-rooms. They are required by the women scrubbing the floors, for the emptying of wash-water, and to draw clean water.

The general principles of sanitary house drainage *apply* with full force to the plumbing of theatres, and inasmuch as I have frequently discussed and described the latter in various books and pamphlets, which are readily accessible, and because there is nothing really new to be said, the subject must be dismissed with these few words.*

4. **Water-supply System.**—Theatre buildings require a very ample and large supply of water. There should be, in each theatre, two entirely distinct systems of supply, one of which serves the purpose of fire protection, while the other system provides water for the plumbing fixtures, for flushing, washing, and general cleanliness.

The water supply for fire-extinguishing purposes embraces large suction-tanks in the basement, roof tanks to supply the automatic sprinkler system, and a powerful fire pump in the engine-room which supplies the fire stand-pipes and fire-valves. This system has been elaborately described by the author in his two books on "Theatre Fires and Panics," and on "Theatres, Their Safety from Fire and Panic, Their Comfort and Healthfulness" to which those interested are referred for further details.

The house supply should be entirely separate from the fire-service supply. Where the street pressure is insufficient to supply the plumbing fixtures in the upper parts of the theatre, special house tanks should be provided on the roof over the stage. It will readily be seen that it would be inadvisable to use the sprinkler tank for such purpose, as it might be found empty at

* See "House Drainage and Sanitary Plumbing"; also "Sanitary Engineering of Buildings."

a time when water is wanted for fire-extinguishing purposes. The rules of the National Board of Fire Underwriters wisely specify that no branch for sinks or for drawing water for any purpose whatsoever shall be taken from the sprinkler tanks.

Sometimes house tanks placed above the highest plumbing fixtures, for instance on one of the upper flies or in the rigging loft, fill at night by pressure from the street mains; in the majority of cases, however, it is necessary to pump the water to the tank, which is accomplished by means of direct-acting steam-pumps, or by electric pumps, or hot-air engines, or even windmills placed on the roof.

The house-water service comprises also a hot-water tank, because the players and supers require, in their dressing-room, hot water in abundance at the basins and wash sinks to remove the face paint, etc. Hot water is likewise required at the slop-sinks for the use of the scrubwomen.

Regarding the water service-pipes, their material and arrangement, the shut-offs on the lines and their branches, the system does not differ essentially from that provided for other public buildings. Where drinking water is provided on the stage, and in the corridors outside of the dressing-rooms, filters and likewise water-coolers may be required. These do not present any special feature worth mentioning.

5. **Ventilation.***—I come now to a very important requirement of theatre buildings, namely, that of ven-

* See Appendix B.

tilation. I have already made allusion in my introductory remarks, to the almost universal lack of ventilation in theatres, which causes the restlessness, languor, and drowsiness of theatre audiences, and I have pointed out, that a wise and thoughtful theatre manager will, in order to insure a "full house," use all possible means and care to have his house well ventilated, for nothing contributes more to the enjoyment of an audience than pure air. Indeed, it may be asserted that in the future those theatres will be patronized by the public by preference, which are as safe as they can be made from the danger of fire and panic, and which also have an efficient system of ventilation.

It is impossible in a short article to discuss in detail the various systems and methods of theatre ventilation.

When new theatre buildings are to be erected, architects should always associate with them an expert in heating and ventilation, which two problems always go together.

It is necessary that every part of a theatre should be ventilated, not only the auditorium, but likewise the stage, the dressing-rooms, the understage, the engine-room, the vault where the gas meters stand, and finally, the numerous toilet and retiring rooms in both parts of a theatre.

The amount of ventilation to be provided varies with, and depends largely upon, such features as the mode of lighting employed, whether by candles, by oil lamps, by gas light or by electric light; upon the size of the building and in particular the number of people which can be seated in the entire auditorium; and also upon the general state of cleanliness of the building, to which I shall refer again hereafter. The introduction of electric lighting in theatres has without doubt contributed more than any other agent to render this vexed problem a good deal easier to solve.

In designing the system of ventilation for a theatre it should be borne in mind that ventilation means not merely the removal of foul air, but simultaneously the introduction of a sufficient quantity of pure air, drawn from a suitable source out-of-doors, suitably filtered and warmed in winter time, suitably sprayed or cooled with ice in summer time, and introduced at all times without any unpleasant air currents or draughts.

It is manifestly insufficient, then, to merely provide in the auditorium a few outlet flues and ventilating registers of restricted size for the removal of the foul air, and to rely upon fresh air being drawn in through accidental openings, or cracks or crevices, or from the level of the stage. Both inlet and outlet flues of generous size should be arranged in all cases, and care should be taken that they are in no way obstructed. There should be a supply of fresh air to each and every person in the audience, equal to at least 30 cubic feet per minute, or 1800 cubic feet per hour. General Morin, in his well-known "Treatise on Ventilation," suggests a supply of 1200–1500 cubic feet per person per hour. In a theatre of medium size, seating 1000 persons, the former allowance means an hourly supply of pure air of 1,800,000 cubic feet. It will be obvious that it is not quite an easy problem to furnish and admit such vast volumes of air, particularly when introduced near the floor level, without causing air currents which may be unpleasantly felt by theatre-goers. To warm this quantity of air in winter time, when the thermometer out-doors stands near the zero point, to about 68 degrees, means likewise to the theatre manager a good deal of expense for coal. The system must therefore be carefully laid out and calculated to secure results which will be satisfactory to all concerned.

It is obvious, furthermore, that to introduce and to distribute evenly such large volumes in all parts of the audience hall, recourse must be had to forced or mechanical ventilation, by means of fans or blowers. In the *plenum* system of ventilation, draughts are avoided by forcing the pure warmed air into the auditorium under a slight pressure.

The fresh air may be introduced at the top of the house, through the ceiling, and made to move downwards in a steady and uniform current, until it reaches the lungs of the spectators, and the exhaled air is then removed at or near the floor line. On the other hand, it is possible to bring in the fresh air at or near the bottom, and to exhaust it at the ceiling of the hall. We accordingly distinguish between the two systems of *downward* and *upward* ventilation. Much has been written about these systems, and arguments in favor of both may be found in any good text-book on Ventilation. To a certain extent, both systems may be successfully planned and arranged; the plan and subdivision of the theatre building, the details of construction, and local conditions will generally decide the question which one is to be preferred. Where a theatre is lighted with electric lights, the downward system of ventilation shows better results than where gas lights are used.

A good system of ventilation should effect a complete change of air three or four times an hour, and this change of air is required not only in the auditorium, but also for the foyers, the stage, the dressing-rooms, and toilets.

It is stated, on good authority, that efficient ventilation improves the acoustic properties of a theatre. On the other hand, the question of ventilation should always be treated in connection with the question of safety from fire. To depend, for example, for the ventilation of the stage upon a strong current of air from the stage towards the auditorium, seems to me to be a grave mistake. For, with such an arrangement, in case of a fire on the stage—and it is proven by statistics that the majority of theatre fires have their origin on the stage—the smoke from the burning scenic decorations, etc., would be drawn into the upper part of the auditorium, suffocating numberless persons in the gallery before they can make their escape from the burning building. On the contrary, it appears to me that it should be the aim to create, in such cases, a strong current away from the auditorium in the direction towards the stage. Doubtless, this can be efficiently accomplished, and one way of doing it is to provide large ventilators in the roof over the stage. With the stage cut off from the auditorium by a fireproof or fire-resisting curtain, of asbestos cloth, for instance, the audience would have plenty of time to escape unhurt, and repetitions of fire catastrophes, such as those of the Ring Theatre in Vienna, and of Nizza, would become impossible.

Leaving aside, however, the question of fire, it seems but reasonable to require that the stage should have at all times thorough ventilation. The fumes incident to colored fires, the smoke due to burnt gun powder, slight gas leaks and other stage odors should never be allowed to penetrate the auditorium. Whoever has been an eye-witness to the endless coughing and sneezing of the audience after a battle scene, such as that presented recently at the New York Academy of Music, in the play of "Shenandoah," will agree to my proposition that separate stage ventilation is extremely desirable.

There should always be adequate actors' dressing-room accommodations. These rooms, too, require to be efficiently ventilated, preferably by windows to the outer air, or by special vent shafts, where windows are out of the question. Finally, the toilet-rooms require a constant change of air, and an abundant supply of fresh air to keep them sweet and wholesome. Special stress should be laid upon the necessity of arranging for a current of air from the halls into the toilet-rooms, and not *vice versa*, for otherwise, however well the system of ventilation may work, unpleasant odors from the water-closets and urinals may penetrate to other parts of the theatre.

The boiler- and engine-rooms should also have plenty of fresh air, and all building regulations provide that the vaults where gas meters are set, must have suitable ventilation, to prevent explosions of gas.

6. Lighting of Theatres.—In the matter of lighting, I have already pointed out that with the advent of the incandescent electric lights a new era in theatre sanitation has begun. Possibly some readers may remember the primitive methods in vogue years ago of lighting up the stage and auditorium of a theatre by means of tallow candles. Not only was this mode of illumination fraught with danger from fire, but the smoke and the greasy smell from the candle lights rendered actual enjoyment of a play impossible. A slight improvement was effected when oil lamps and Argand burners were substituted for the open candle flames, but still the danger from fire was not lessened to any extent. The introduction of the gas light brought increased illumination, but it also increased immeasurably the fire risk, particularly on the stage. The innumerable open gas flames both on the stage and in the auditorium, and the objectionable central chandelier in particular, created a powerful air contamination, so that good ventilation seemed almost out of the question.

The electric light has not only rendered theatres vastly better and safer from the danger of a conflagration, but it has helped to solve, more than anything else, the question of theatre ventilation. Anyone may verify this statement by visiting successively one of the modern theatres lighted by electricity and one of the older theatres lighted by gas flames. As a matter of safety, building regulations require for theatres two kinds of illumination, namely electric lights for the auditorium and the stage, and in the corridors, staircases, foyers, and exits an auxiliary system of candle or oil lamps, but it is wisely required that these auxiliary lights be set in wall niches provided with separate ventilation to the outer air. Where two independent sources of the electric current can be had, the auxiliary system of lighting may consist of electric lights supplied from a current other than that which supplies the auditorium and the stage.

7. **General Sanitation.**—Having now discussed the important requirements of drainage, plumbing, water supply, ventilation, and lighting, it remains to speak briefly of some matters connected with general cleanliness in theatres. From what follows, it will be seen that all measures tending to insure cleanliness, will also help to improve the ventilation by removing sources of air pollution, such as indoor dust, accumulations of dirt and rubbish, slops and oily wastes, ill-kept plumbing fixtures, etc. At the same time, a due regard for these details of theatre management will render a theatre building in many respects safer from the danger of fire.

That the floors, walls, chairs, and seats in a theatre building should be kept clean goes without saying, yet, in how many instances is the reverse true! All manner of rubbish and dirt should be removed from the theatre daily; both the stage floor and all parts of the auditorium should be swept and thoroughly dusted and cleaned out every morning. The dusting should be done in such a manner that the dust will not merely be floated in the air, to settle again upon the floor covering, the upholstery, and the decorations.

The floors should be scrubbed and swept, but care should be exercised not to make them so wet as to smell murky and damp in the evening. Where possible, the hall should be flooded with outdoor air once a day. If some sunlight can be admitted all the better, for I need not state that sunlight is a better disinfectant than any artificial or proprietary article, no matter how well it may be advertised.

The dust accumulating in a theatre is a far more serious danger to health than most persons are apt to believe. It is but necessary to contemplate for a moment the vast amount of out-door dust and dirt, carried daily and nightly into a theatre by the many hundreds of persons who go to see a play. The dirt which clings to the shoes is partly deposited in the floor carpets, and often, I regret to say, expectorations are added, which in the case of persons suffering from pulmonary troubles, may be laden with the germs of tuberculosis. Unless the utmost care is exercised in sweeping out the floor and in dusting off the chairs and the upholstery, the finer particles are not removed but continue to float about in the air, and finally settle on the floor covering and in the plush of the chairs, and are again stirred up when a new audience enters for another evening's enjoyment.

Little attention has in the past been devoted to the question of suitable furniture and upholstering of audience halls. I am inclined to think that, as a sanitary preventive measure, all plush upholstery and other material catching and holding dust, and all heavy hangings and decorations of the boxes should be done away with in theatres. Chairs covered with leather would be far better, and doubtless other sanitary furniture coverings are available. As a safety measure against outbreaks of fire, the decorations of the front of the boxes and of the proscenium opening are called for in building laws to be of fireproof material. The flatter such decorations are made, the better they are from a sanitary point of view, for then they will not so easily catch or hold dust. Then there is the question of suitable sanitary floor covering. I hold that carpets should not be tolerated. There are better, not more expensive floor coverings such as linoleum, or the recently introduced interlocked rubber tile floor covering which commend themselves to me as vast improvements over carpets. Handsome patterns of these new sanitary floor coverings may doubtless be obtained should a demand for them for audience halls arise; but in any event, the question of decoration should in my judgment be subordinate to that of health. "Salus Publica Suprema Lex" is an old saying, which may be aptly applied to this entire question.

With such improved furniture and floor coverings, dusting, if done under the watchful eye of a special theatre inspector, would be freed from the ordinary ever-present dangers.

Let me add that the same person intrusted with the cleaning up of a theatre, should be in charge of the proper maintenance of all toilet-rooms, for here again eternal vigilance is the price of safety. Plumbing fixtures in a public place are too apt to be abused, no matter how well arranged, therefore frequent applications of soap, brush, and hot water are necessary to keep the appliances free from odor.

In the matter of floor space allotted to each person in the audience, there is also much room for improvement. The floor area for each person should be more generous, particularly in the gallery, the seats should be wider and made more comfortable, and above all, there should be plenty of wide gangways and aisles to secure a quick emptying of the house.

In conclusion, I must mention another matter of importance in which the theatre-going public is interested. I refer to the drinking water, kept in water-coolers and pitchers, or served recently in some theatres on neat trays to the patrons of the lower parts of the auditorium. The drinking water should be filtered by one of the few really germ-proof filters. These filters should be cleaned often, and occasionally sterilized. Where water is cooled by means of ice, it should be done in such a way that the melted ice will not mingle with the drinking water. It is well known that ice frequently contains organic impurities and germs of disease; it would, therefore, be a useless proceeding to first filter the water and to render it afterwards subject to pollution from impure ice.

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For the Literature on Theatres the reader is referred to the bibliography in the author's book: "Theatre Fires and Panics: Their Causes and Prevention," published by John Wiley & Sons.

CHURCH SANITATION

III

CHURCH SANITATION

If one could form a right conclusion from the small number of instances, when sanitary and ventilating engineers are professionally consulted in the case of church buildings, one would naturally infer that sanitation is not required, and certainly very little thought of, in the planning and erecting of houses of worship. On the other hand, when we take into consideration the fact, well established by recent examples, that a modern large church edifice requires not only drainage and sewerage, water supply, and gas piping, the same as any other building, but also contains quite often an elaborate array of plumbing fixtures, in the shape of toilet-rooms, kitchens, serving pantries, gymnasia with baths and lockers, and, for some denominations, immersion pools, etc., it would seem that a short chapter in a work, intended to describe the different sanitary engineering features of the more important public buildings, should be devoted to "Church Hygiene."

It is, perhaps, a trite saying that "cleanliness is next to godliness," but nevertheless it seems quite applicable to buildings in which the gospel is preached and in which a large audience takes part in religious services.

It is estimated that approximately 4000 churches are built every year in the United States, and it is a fact that in by far the largest number the purely utilitarian features of construction and equipment are either very little thought of or neglected altogether. Even the municipal departments whose duty it is to watch the construction, ventilation and sanitation of buildings, and which have in the past decades made numerous reports and examinations regarding the sanitary condition of school-houses, hospitals, and tenement-houses, have but very seldom inquired into the conditions actually existing in many church edifices.

1. Sanitary Defects in Churches.—Occasionally the subject is taken up by the newspaper press, and articles such as the following on "Church Sanitation," taken from the *New York Times* of May 21, 1900, call the attention of the general public to the undesirable and unsanitary conditions existing:

"In the arrangement made by the Trustees of our city churches for the general overhauling and renovation, for which the vacation season affords opportunity, we suggest that a thorough sanitary survey and inspection be included.

"We have in mind a large church which, if not distinctly typical, is at least a conspicuous example of the tendencies of modern church architecture. It is a comparatively new church, costs a great deal of money, has a large and wealthy congregation, and is greatly admired. It occupies an area equivalent to about five city lots. The auditorium is beautiful, with excellent acoustic properties; it is well lighted, equably heated, and fairly well ventilated. Owing to the necessity for economizing ground space, the principal Sunday School room is in the basement, under a portion of the auditorium. This is unfortunate, as it is usually damp, and under some atmospheric conditions distinctly 'musty.' To give this basement light and ventilation, an area about ten feet wide has been provided on one side of the building, extending its entire length. It has a flag bottom and brick or stone sides. Near the bottom of this area are the metal gratings covering the air intakes for the hot-air furnaces, which are brick tunnels under the basement floor. The area is usually damp and always more or less dirty. It is a catch basin for all kinds of street dirt, carried and dropped by the wind eddies, and a great deal of this dirt in dry and windy weather is swept into the air ducts by the inflowing currents. In winter, this area contains more or less dirty ice and snow, which melts slowly and loads the indrawn air with moisture to a point of saturation. The air ducts under the cellar floor have never been examined or cleaned since the church was built and their condition is a matter of conjecture. It may, however, be safely assumed that they contain a great deal of dirt of the average composition of street sweepings. The arrangement we have described, though quite usual in both church and house construction, is distinctly bad and positively dangerous. To take air for heating and distribution by hot-air furnaces from the ground level is to insure getting with it a great deal of dampness and dirt; to take it from subterranean pockets, uncleaned, unsunned, and generally neglected, is to make the matter worse. Such air is unfit for breathing, and accounts for many diseases of the breathing organs, especially in children, among which bronchitis, croup, diphtheritic sore throat, and true diphtheria may be included.

"In the church we have described there are plumbing fixtures scattered about. The modern church needs toilet-rooms. The fixtures are placed in out of the way corners, in dark closets under stairs, and where adequate ventilation for the apartments containing them is impossible. Indeed, no attempt has been made to secure it. The suggestion that this might be dangerous was brushed aside by the sexton on the ground that they are 'not much used.' These fixtures discharge through long and of necessity nearly, if not quite, horizontal lead wastes into a common drain under the basement floor, which is also a channel for rain-water caught on part of the roof. During a heavy shower the rush of water through this drain will unseal every trap in the building. Some of the fixtures are not used oftener than perhaps once a month. Meanwhile they are forgotten. No provision has been made for flushing these traps, and as a consequence they are either foul or dry most of the time.

"A portion of the basement is used for a lumber room. This is usually full of rubbish which has no other function than to increase the fire risk. Broken furniture, worn-out hassocks, discarded pew cushions, bits of old carpet, dilapidated hymn books, and the like are piled up with intervening dust strata in great confusion. In this compartment is a small supplementary furnace for emergency heating, which draws its air-supply from the room at the floor level.

"The church, Sunday school, and lecture room, the principal stairways and passageways, are carpeted. These carpets are tacked to the floors, and are taken up for cleaning once a year. Between December and June they become extremely dirty. Pew cushions are beaten and brushed once a year—at other times they are superficially dusted. In none of these matters is there any deliberate neglect. The difficulty is that they are left to the discretion of the people who do not know what the hygiene of a church requires, for whose guidance no code of rules has been formulated, and whose work is not supervised by any one with a knowledge of how it should be done. Behind this negligence, and emphasizing it, are original faults of construction, largely the result of a mistaken idea on the part of the architect that in church building it is proper that everything should be sacrificed to a more or less successful imitation of mediæval standards of construction and decoration. It is not difficult to understand these preferences of the architect; but for practical laymen charged with the management of church temporalities it should require no argument to show, that the duty of making and keeping church buildings safe places of assembly for adults and children is a personal obligation, which cannot be delegated to anyone. There is no warrant for the notion that because a church is occupied only a few hours a week its sanitation is safely negligible. Holiness and malaria are not twin sisters, and should not be made to go hand in hand."

Making due allowance for some pardonable exaggerations and some minor inaccuracies, the article quoted above is worthy of serious attention of those who make a specialty of planning and erecting church buildings.

When the author, in 1898, presented to the American Public Health Association a paper dealing with the subject of "Theatre Sanitation," the same was not only widely commented upon, but its chief points were extended and applied by reviewers to the sanitation of churches. Thus, in the *Medical Record* of January 7, 1899, appeared an editorial, entitled "Sanitation of Public Places of Amusement and Churches," from which a few quotations appear to be appropriate:

"The hygienic arrangements of theatres and other places of amusement are all the world over disgracefully neglected. The importance of the thorough sanitation of schools and similar institutions is now fully realized, and no expense or trouble is grudged in carefully looking after the bodily as well as the mental welfare of the young. Not only do parents insist that the schools they select for their sons and daughters should be in a good state of sanitary soundness, but those in authority evince a praiseworthy disposition to see that the atmosphere of the educational establishments is pure and wholesome. It is therefore decidedly curious that the greater portion of the adult members of the community exhibit a complete indifference towards matters hygienic in connection with theatres and music halls. One reason for their careless disregard of the laws of health is without doubt owing to the fact that a stay in a place of amusement is necessarily brief, and that, so long as attention is paid to pleasing the eye and ear, it appears to be a question of small moment whether the air is healthy or foul. Nevertheless, there are signs that the general public are becoming more alive to the dangers lurking in theatres and establishments of a like nature, and it is probable that in the near future the construction of buildings devoted to pleasure will be conducted with a due regard to the health of their patrons . . . For the most part, theatres, concert halls, and places of the same class are but 'whited sepulchres,' externally and internally gorgeous and often artistic, but woefully lacking in almost every other respect. Many of them have but few windows and no means of renewing the air when empty. Their location is often in a high degree prejudicial to health. In large towns like New York, London, Chicago, where space is valuable, such establishments are not infrequently pushed in between immense buildings, with scarcely any frontage. The sewerage is bad, and indeed Mr. Gerhard says that 'he knows of at least one theatre in Greater New York where, each time the curtain rises, a strong whiff of sewer air greets the audience'. The fact, then, that the system of the sanitary arrangements of most places of amusement is altogether wrong may be taken as proven, and the question remains, in what way can a thorough change for the better be brought about? To touch even briefly upon the many points of sanitary reform which can and should be effected in the sense-stimulating and mind-relaxing establishments of the people, is a subject quite too intricate and arduous. However, as to ventilation, the opinion of experts would seem to be that the mechanical method by propulsion is the only one whereby a theatre can be properly aired, and that there should be an allowance of about eighteen hundred cubic feet of pure atmosphere per hour for each individual. A person does not care—be the entertainment provided for his delectation as excellent as possible—to run the risk of being poisoned by foul air. If the public will make a determined stand and refuse to sit in an unhealthy building, an alteration in the existing condition of affairs will be quickly affected. So long as playgoers are indifferent the managers, whose sole object would appear to be to make money, will allow matters to remain *in statu quo*.

"Theatre proprietors are unfortunately not the only sinners as regards the health of their congregations. Churches of all denominations are in many instances overcrowded and insufficiently ventilated. These remarks especially apply to the Roman Catholic houses of worship. These are in the majority of cases ill-lighted from without and either stuffy or draughty. Masses in many of them are held at frequent intervals, at which all sorts and conditions of people are present. This is, of course, as it should be; but, after all, the worshippers have a right to expect that a certain amount of consideration should be given to their bodily well-being. At a church, as at a theatre, it is impossible to provide a sufficient allowance of pure air by means of windows or other openings. Consequently the only effective alternative is the mechanical process of ventilation already referred to.

"The *London Times*, in an article written in January 1896, refers to the subject of overcrowding in churches thus: 'We regard this as a highly objectionable practice in two respects—first, on account of the danger of blocking the exits in case of panic, and second, because of the injury to health caused by cramming a building to its utmost capacity. Churches are never too well ventilated, and there should be a definite limit imposed upon the members of the congregation." Both theatres and churches are a long way from being hygienically perfect, and it rests with the general public that the necessary reforms should be introduced."

It is not alone in the construction and equipment of churches that many sins of omission and commission are perpetrated, but in the management of such buildings after their completion much negligence or indifference is apparent. It is very often found that an entire and serious disregard to sanitary maintenance exists. Witness the following comments which appeared some years ago in the *New York Independent*, under the heading "Church Sanitation."

"Some of the greatest breaches of sanitary law and sanitary administration are to be met in our churches. The mere sweeping and dusting of a church requires all that care and attention which is bestowed by the good housekeeper upon her house. Generally this work is committed to men not trained in any such service. The carpets and cushions of many a church receive but a very rare shaking, and no such rubbing and dusting as are necessary to sustain cleanliness.

"But it is especially in matters of ventilation, heating, and lighting that we suffer from the mismanagement of churches.

"When a congregation is dismissed, the first business of the sexton should be a thorough ventilation of the building. This does not mean merely the pushing up of a window or two. With the tendency that air has to cling to surfaces, and of floating particles to do the same, any crowded church needs such thorough flushing with air as can only be secured by a very extensive opening of it to the outer air. This may not be necessary nor possible between a morning and evening service, but it is especially desirable after the latter. From inquiry, we believe it to be the more common practice for the airing to be left until the day before the Sabbath, and then for it to be done in a very imperfect way.

"The church is thus left filled with the contaminated air for nearly a week. It lacks the advantage of a house that is used every day, which gets some ventilation by the opening of doors and windows and the passing in and out of occupants and guests. The stifled air settles about its corners and crevices, or sinks along the pews, and is not easy removed by the work of the following week. Indeed, there is often painstaking not to remove much of it, but to keep it for the hasty warming. It is too little realized that the numbers of people and the multitudes of lights at evening very rapidly exhaust the oxygen from the air.

"At the close of a day's service there is a reservoir of impure air, which should be peremptorily turned out-of-doors. The day following the Sabbath is the best cleaning and regulating day for church assembly-rooms. The design of the previous afternoon or early Sabbath morning opening should not be the removal of foul air, but of any dampness, by letting in fresh air, and sunshine. It is the proper union of these two methods that secures the best condition of air for churches.

"As all large assembly-rooms are difficult of regulation as to draughts, churches should not depend much on window ventilation during service. If they do, the persons in adjacent pews, or those receiving the air on the back of the heads or necks, not infrequently take cold. When window ventilation is at all relied upon, pieces, or strips, of board should be placed so under the lower sash as to make an inlet between the upper and lower sashes when the latter is raised and the strip of board placed under it. Where windows are open from the top, those on the opposite side of the room should be shut, that direct draughts may be prevented. The Tobin system of ventilation, or some other by which air is admitted through the walls and at a height above the heads of persons standing, is much better than the usual window ventilation. Openings above lamps and chandeliers aid in the removal of foul air, but in large rooms not so much as is generally supposed, unless there is additional aid to exhaust the room or attic above.

"Churches suffer much from imperfect modes of heating. Often there is an attempt to make one or two furnaces do the work which should be distributed among several. It is hard to distribute heat from one centre over a large assembly-room. When the attempt is made, the furnace is driven at such a heat as to introduce air at entirely too high a temperature for comfortable diffusion. In the attempt, carbonic oxide and various gases of forced combustion are blown in with the heated air. There is also that burnt feeling of the heated air so often complained of, and an absence of moisture, which makes sudden demands upon individuals as well as upon surroundings. If most of our churches are to continue to depend upon furnaces, we are not sure but that fireplaces will have to take their places in various corners, as a means of ventilation.

"Every sexton needs to make the particular building he superintends a study as to its administration. In this he must keep clear of notions and of mere sensations. The thermometer here and there should tell him the actual warmth. He should know how to test draughts, and then should not be governed by the feelings of others."

On the other hand, in exceptional instances, the very minutest attention is paid in some churches to the maintenance of healthful conditions, and as a case in point, I quote from an article in the *Sanitary Record and Journal* on "Church Hygiene," the following brief statement showing that cleanliness and sanitation are receiving, in some quarters, all the attention which they deserve.

"In view of the remarks, recently published in our columns, on the relation of the church to sanitation, some information appearing in a French journal is not without interest. It seems that the Italian Bishop of Fano has sent out a circular to the priests of his diocese, directing that in all churches immediately after feast-days, on which there have been very large congregations, the floors must be disinfected by means of wood saw-dust soaked in a one-tenth percent solution of corrosive-sublimate. On ordinary days, they must be frequently swept, after sprinkling them with water, so as to raise no dust. It is further directed that every week, and even oftener, the pews and confessionals must be cleaned with sponges and cloths moistened with pure water, and that every week, and oftener, if necessary, the grilles of the confessionals are to be washed and polished, while the holy-water receptacles must be emptied every week, or oftener if necessary, and washed with hot water or a solution of corrosive-sublimate. In order that these provisions may be carried out, the Bishop has instituted a service of inspection, and requires the payment of fines into the diocesan treasury for transgression of any of these hygienic rules. The journal responsible for the foregoing expresses the hope that the Bishop of Fano's example will be imitated by church authorities in other countries."

2. Sanitary Inspection of Churches.—A few years ago, in December 1902, the officials of the Health Department of the City of New York made an inspection of about two hundred and fifty churches and synagogues in the Borough of Manhattan, and this, to my knowledge, was the first inspection of the kind ever undertaken by such a department. The official report on the inspection is probably not accessible, but sufficient was learned from it to establish the fact that the result of the inspection was an unfavorable one. In fact, conditions were found to exist in at least fifty of the churches examined of such an unsatisfactory nature as to seriously endanger the health of the congregation and of the children attending the Sunday-school. It is stated that the worst conditions were found in some of the older downtown churches, which, not being as prosperous as in former times, neglected to maintain or instal suitable systems of ventilation, sanitation, and sewerage. In commenting upon these statements, a writer in the *New York Times* mentions that considerations of economy were probably the principal cause for the sanitary neglect. He cites the deplorable fact that Sunday-school classes were held in basements with very imperfect ventilation, the toilets being in some cases separated from the main class-rooms only by thin partitions and not being provided with any outside windows. It is no wonder that, under such conditions, complaints had reached the Health Department officials that children had returned from Sunday-school made ill as a result of the impure air of the class-rooms. By the same inspection, some synagogues on the lower east side of New York City were found to be in an extremely unsanitary condition. In some localities the synagogues are merely parts of buildings, of which the remaining portions are devoted to sleeping quarters on the upper floors, and to shops on the ground floor. Many evidences of a surprising disregard of all considerations of sanitary conditions on the part of the church authorities were discovered.

It is not necessary to go further into the details revealed by the examination of the officials, but it is to be hoped that the efforts of the Department in improving the sanitary condition of the churches of New York, by sending formal notices to the Board of Trustees, and by informing the pastors of the congregations of the sanitary defects discovered, will lead to an improvement in such structures, which is required alike by considerations of decency and health.

In the City of Chicago, the Health Department, through its chief sanitary inspector, has recently given considerable attention to church ventilation and sanitation. Commenting on the results of his inspections, he said among other things:

> "The air in most of the Chicago churches will send people to heaven quicker than any of the preaching they listen to. The churches, especially the Protestant churches, are locked up all the time, with only brief intervals for services. The result is that they are never properly ventilated, and the air becomes surcharged with germs worse than exist in any theatre or wordly place."

It was also found that conditions were not quite so bad in the churches of the Roman Catholic denomination and in Episcopalian churches, because the doors of these are open more of the time, and are thus given an incidental ventilation.

Much good would be accomplished if the example set by the New York and Chicago Health officials would be followed by other cities.

It is a well known fact that clergymen are often susceptible to headaches and find themselves completely exhausted at the end of a church service, or at least at the beginning of the summer vacation. The reason for this all-prevailing feeling of lassitude is not very far to seek, it being doubtless caused by the often intolerable condition of the air breathed during the evening services in a crowded church. The effects on the audience of the steady increase of impurities of the air are in many cases distinctly perceptible during the last part of the minister's sermon, whereas in those churches where healthful conditions exist and a perfect system of ventilation is installed, there will be found few, if any, drowsy or sleeping people in the pews. In the majority of church buildings, ventilation is entirely ignored and the only means provided for effecting some change of air are the windows in the clerestory, and these of course can only be utilized in summer time.

No less an authority than Dr. John S. Billings states in his classical work on "Ventilation" that "the churches are like theatres as a rule, at least in one respect, namely, that they have insufficient and unsatisfactory arrangements for ventilation. The auditorium is either insufficiently heated, at least in very cold weather, or during periods of milder weather they become overheated when the audience is large. Complaints of unpleasant draughts are very frequent. Special arrangements for the uniform distribution of a sufficient amount of pure, warmed air throughout the auditorium are only to be found in some special instances where either the architect paid particular attention to this subject, or where a special heating and ventilating engineer was entrusted with the problem."

In an excellent little treatise on "Ventilation and Warming," published in London in the year 1894, the late author, Ernest H. Jacob, makes a plea for the employment of engineering specialists in the different branches in the following words:

"Through the rapid increase of knowledge on sanitary subjects, the architectural profession has burdens laid on it heavier than it can bear, and it is only by co-operation of architectural and sanitary experts that we can hope to erect buildings on a level, not only with the artistic taste, but also with the sanitary knowledge of the day. . . .

"It is not long since an architect of Antwerp actually refused to carry out the erection of a town hospital, because the Hospital Committee would not appoint an engineer to consider the plans with him with regard to heating and ventilation, before the foundations were laid."

3. Application of the Principles of Sanitation to Churches.—Church hygiene comprises the practical application of the general principles of sanitation to church buildings. The subject is an extensive one, and only the more important matters can be mentioned here. The building of churches is, as a rule, placed in the hands of Committees, composed of laymen who are without previous experience in such work, and often even without a general knowledge of any kind of building enterprise. It is, therefore, all the more important that the Committee should place reliance upon the professional advice given them by their architect. A competent and well informed architect will surely impress them with the importance of sanitation, and tell them that the often-heard excuse that "a church is occupied only a few hours a week, hence its sanitation may be neglected," cannot be considered a valid one. It should also be his duty to point out that rather than put a considerable amount of money into expensive stained glass, sculptures, paintings, bronzes, and other works of art, screens, furniture, and ecclesiastical fittings, it is wise *to spend some* money for efficient ventilation.

4. Building Site.—The site for a church should be central and convenient of access by the various transportation routes. It is desirable that a church edifice be located at a prominent street corner. In European cities one often finds such buildings located on open squares, a precedent, which, however desirable it may seem, cannot be followed in our cities owing to the high value of land. The size of the lot should be ample for the requirements of the congregation, and it should permit of the location, not only of a church building, but in some cases of other buildings required in connection with the same, such as the parish house, the minister's house, and the Sunday-school. Whereever it can be done, it is desirable to have some open space around a church or between its buildings, as this will not only enhance the architectural effect, but will secure better air and light. It is not difficult to embellish such open spaces with landscape gardening in keeping with the objects of the building.

5. Plan and Construction.—Many churches are built with only one story and thereby gain the advantage of greater ease of access and of less danger in case of fire and panic. A few churches are built with a basement story entirely above ground, but the majority of churches have, in addition to the main floor, a basement or cellar, located partly below the grade level. This cellar or basement is required for the installation of the heating apparatus, for fuel storage, and for the location of the gas or the electric meters. The Sunday-school is in many churches located in the basement, but such a location can only be tolerated from a sanitary point of view when the soil is perfectly dry and the basement made damp-proof.

The plan of the building is in most cases that of a rectangle, but in a few instances it is square; the larger cathedrals are usually built in cruciform shape. In such a building, the principal room or hall is the auditorium, or the place where the congregation meets for worship and for the observance of religious services and ceremonies. The seats for the worshippers are arranged in the nave, and sometimes in the transept of the church, and in addition there must be a place for the choir, besides the chancel with sanctuary and altar. In connection with the main auditorium we must consider the entrances, vestibules, the stairs and the gallery. The gallery is provided to gain additional seating capacity for special occasions of larger attendance, though in some denominations, and notably in some of the Jewish buildings of this class, a separation of the men and women is made, and the women are assigned to the gallery.

Where the plan of the church provides for a Sunday-school adjoining the auditorium, the gallery is sometimes omitted and in this case increased seating capacity is gained by opening the doors between the two. In large churches a number of other rooms may be required, notably the study for the pastor with an adjoining toilet-room, a choir-room, a robing-room, a special meeting-room for the trustees, a lecture-room or chapel, and a ladies' parlor. The social features of a church society require a good deal of consideration, and in addition to the rooms mentioned we find sometimes a reading-room, a drill-room, and in a recreation building bowling alleys with lavatory and gymnasium, with baths and lockers.

6. Precautions against Fire and Panic.— But few churches are built thoroughly fireproof, hence we always find in the published tables which give the annual loss by fire, a number of churches. "Surely there is something wrong in the materials used in church building," said a writer in the *New York Times* after the destruction of St. Thomas' Church in New York City in 1905, "if they can flare up and go up in smoke. . . . Is it not possible to substitute non-combustible materials for the galleries, pews and inner walls?"

At special church festivals there is considerable overcrowding, hence the danger from panic and from fire is ever present. The blocking of the exit doors, in case of panic, would be particularly serious and hence much attention should be given to the planning of the entrances and exits. They should be commodious and sufficient, in width and in number, to empty a church quickly. Large churches should have more than one entrance, and there should always be a special entrance for the Sunday-school. The main exit doors should be hung so as to open outward, to avoid a jam in case of a panic.* The inner vestibule doors may be hung on double-acting spring hinges. The vestibules should be spacious and capable of holding a large crowd.

Where there is a gallery, the stairs leading up to it

* See Wm. Paul Gerhard, "**Theatre Fires, and Panics: Their Causes** and Prevention."

should be wide, without windows, and with a convenient proportion between risers and treads. Where there is an attic over the church auditorium it should always be made accessible by stairs, as it will necessarily contain the distributing lines for the gas cluster lights and the electric wire conduits.

To enable the quick emptying of a church after services it is further important that the aisles should be of sufficient width. These should never be less than from four to five feet wide, this depending upon the size of the church, and the arrangement of tapering aisles, which has been suggested, has much to recommend it. It is usual to have a central aisle and in addition to the same some times side aisles. The centre aisles, which are necessary in the case of certain religious ceremonies, have both advantages and disadvantages, but whether centre aisles or two main side aisles are used, the chief requirement is always that they can be reached quickly from the seats, and that they are sufficiently wide to enable persons to get out of doors quickly.

7. **Seating.**—The arrangements of the seats depend principally upon the shape of the auditorium and upon the location of the aisles and exits. The seating may be arranged straight or in a curve, and it is of importance that the spacing between the rows of seats should be generous, to facilitate the moving of the people. For the comfort of the church-goers it is desirable that ample floor space should be allowed for the seats or chairs and it is usual to make this allowance more liberal in churches than in the case of other lecture-rooms. For these it is usual to provide a floor space of six square

feet for each chair, but for the seats in the church auditorium the allowance made is from seven to eight square feet. The floors of the auditorium are either level, inclined, or bowled.

8. Dust in Carpets and Seat Cushions.—It is customary to cover at least a portion of the floor, and also the aisles and stairs and passages, with heavy carpets and these as well as the hair or felt cushions in the pews, with their coverings of plush or other material, accumulate in course of time a large amount of dust, which interferes with proper ventilation. It is important that the carpets, as well as the seats, should be cleaned, swept and dusted every week and it is hardly necessary to state that this should be done in a judicious manner, in such a way that the dust is not scattered throughout the air, but that it may be properly *removed*. The floors require cleaning and scrubbing, for much dirt and dust is carried in by the shoes of persons and by their overshoes in case of muddy streets. At regular periods the floors should be washed by means of some disinfecting solution; this is of particular importance after church festival days. The same remarks apply of course also to the Sunday-school rooms, which require perhaps even greater care, owing to the large number of young children assembled weekly therein.

9. Artificial Lighting of Churches.—The artificial lighting of churches is accomplished by means of gas lights, electric incandescent lights, and sometimes by candles. Both candles and gas burners cause a very rapid deterioration of the air, whereas the electric light offers many advantages in churches as in theatres and other places of assembly. The reflector ceiling lights, being usually in inaccessible positions, should preferably be electric lights, but where gas fixtures must be used, the jets should be lighted by means of electric gas lighting controlled from some central point in the gallery.

10. **Heating and Ventilation.**—Heating and ventilation are two problems of vital importance in the case of churches, and as a rule it is well to consider them together. Until recently, this subject has been considerably neglected, and in one architectural publication on the building of churches I find the subject of ventilation not even mentioned. In another book on Church Architecture the misleading sentence occurs: "the problem of ventilation is a comparatively simple one for churches." (?) As a matter of fact, the subject of ventilating and warming large halls of assembly is quite a difficult one.

Regarding the heating of churches, it should be borne in mind that the persons who attend the churches are usually dressed for walking, hence a lower temperature seems permissible in some cases than is required in theatres or concert halls, where many of the people sit for hours in full evening dress. In some churches, where services are held on Sunday only, it is still the practice not to warm the church during the week, but the majority of churches have also week-day services, and there are many reasons why it seems desirable that such a building should be constantly warmed during the winter season. In the first place, cold down draughts are much more keenly felt in churches which are heated only for Sunday service.

Then again, the plumbing would be very apt to freeze and cause trouble, damage, and expense. Finally, the organ of the church requires a continuous heating because it will otherwise immediately get out of tune. "It is not generally known," says a writer, "how much the organ in a church is affected by temperature. Ten degrees of temperature above that at which an organ is tuned will serve to introduce the most horrible discord in an instrument which had been perfectly tuned."

The heating of churches is accomplished by means of furnaces, or else by steam or hot-water radiation. In the case of smaller country chapels the heating is sometimes done by means of stoves, but these are not to be recommended, except they are arranged as ventilating stoves. If it were not for the requirements of ventilation, it would not be very difficult to warm a church building properly, but the requirements of ventilation signify that large volumes of fresh air must be warmed to a suitable temperature, before being admitted into the auditorium, and this is where both the difficulty and the expense begin. In the case of larger buildings, where one hot-air furnace would not be sufficient, it is generally found to be more economical to arrange for a system of direct and indirect steam radiation, or for a "hot-blast" system. Hot-water heating can be used only in those buildings which are kept warm during the entire winter season, otherwise the hot-water apparatus would soon freeze.

In all buildings, where many persons congregate, the problem of ventilation should receive the greatest attention, but it is unfortunately true that but few churches are satisfactorily ventilated, while a good many of them are either stuffy or draughty. Perfect ventilation would require the provision of thirty cubic feet of fresh air per minute per person, but owing to the fact that a church is occupied for a comparatively short period of time it may seem permissible to make a somewhat lower allowance. The minimum allowance should be six-hundred cubic feet per person per hour. This fresh air should be taken preferably not from near the ground or from basement areas, but from a higher point, and in the case of churches the tower or steeple is quite often made to serve as an inlet for fresh air. The air, after being suitably warmed, should be then distributed throughout the auditorium, and to accomplish this it is necessary that it should be admitted at a great number of points. Floor registers are always objectionable and a good arrangement is to locate the air inlets at the sides of the pews.

Besides introducing pure air, it is necessary to remove the air which has been spoiled by respiration, and by the lighting with gas, and this removal of the foul air can be accomplished by different methods. During cold weather it does not seem feasible to open the windows during the service to let the foul air out, and it is necessary to provide other means. Some ventilation may be accomplished by means of vent-shafts or vent-flues, but unless these are artificially heated they will seldom work well. Where boilers are used, it is generally feasible to locate the smoke-stack in the centre of a large brick chimney built for aspiration and in this way to produce a constant upward draught. Other methods consist in placing steam-pipe coils in the flues above the vent registers or else to use gas jets. A much superior system consists in artificial ventilation by mechanical means and here, the same as in the case of theatres, two methods may be distinguished, namely the exhaust or vacuum and the plenum method. In the latter system, the pure warmed air is forced into the auditorium under a slight pressure. This has some considerable advantages, because in case of leaky windows the leakage is outward and thus unpleasant draughts, such as are common in the exhaust method, are avoided. In addition to operating such a system of mechanical ventilation it seems desirable, some hours before and after each service, to flush the church with pure out-door air by opening all the available windows. Ventilation and proper airing are of particular importance in those churches where more than one service is held in a day, especially so in our large cities, where all kinds and classes of people—the clean as well as the unwashed—congregate.

11. **Basements or Cellars.**—Particular attention should be given to the basement or the cellar of a church, which places are often found to be dark, damp, and musty, and are at times made the receptacle of discarded furniture or other waste material. When the Sunday-school, or any lecture- or meeting-room are necessarily placed in the basement, the greatest precautions should be taken to secure a dry and light basement. The floor should in all cases be concreted or even waterproofed with asphalt.

Where toilet-rooms are provided, these are generally placed in the basement, and this is another reason why the basement requires particular and constant attention. Where it is partly underground, the windows are as a rule provided with areas for the better lighting of the rooms. These areas should be kept thoroughly clean, and those which occur on the street front of buildings, should be swept and flushed with a hose, because a large accumulation of street dirt, sweepings, and litter are apt to accumulate in such sunken areas. It is never advisable to open the cold-air boxes or air-supply inlets for the heating apparatus of whatever kind at such areas, but where they must necessarily be so located, it is advisable not to have the area cesspools, no matter how well trapped they may be, connected with the sewer.

In connection with the Sunday-school rooms there may be one or more cloak-rooms for the outer garments, overshoes, and for wet umbrellas. Some precautions should be exercised to avoid either dampness or disagreeable odors arising fom such places.

12. Sewerage and Plumbing.—The plumbing and the sewerage of a church should, of course, be of the best kind, constructed with first-class materials and arranged in accordance with the modern rules of house drainage. Two dangers exist with plumbing in churches, both of which may be guarded against by judicious management. One danger is that some of the fixtures will not be used much and hence that the water-seal in the traps may evaporate; the other danger consists in *the possible freezing* up of the plumbing pipes and traps.

An efficient and intelligent church janitor would have no difficulty in dealing with these problems.

On account of the social functions connected with church work it is often required to have a well equipped kitchen and a serving-room adjoining the ladies' parlor. These require one or more sinks with hot and cold water, a gas or coal range, and possibly a hot-water boiler or gas-water heater.*

In Baptist churches a baptistry is always provided in connection with one or more dressing-rooms. This is a special tank, from 6 to 8 feet long, 4 to 5 feet wide, and 3 to 4 feet deep, intended for the immersion of persons. It may be constructed of wood and lined with copper, or of galvanized iron, and it requires waste- and overflow-pipes and hot and cold supply-pipes, also a hot-water heater adapted to these special requirements. In the case of wealthy Baptist congregations, the baptistry generally consists of a more elaborate marble pool.

In the arrangement of the toilet-rooms, the general requirements outlined for other classes of buildings should be followed and the chief of these are simplicity

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* A somewhat novel church building has just been completed on the corner of Fifty-sixth Street and Broadway in New York City. This costly structure is said to contain, besides the large auditorium, two chapels, a score of Sunday-school rooms, men's club rooms, women's parlors, and accommodates a total of 6,000 persons at one time. An additional parish house is ten stories high. The church contains also a museum for ecclesiastic relics, a safe deposit vault, and in the basement a theatre stage, with amphitheatre, having seating capacity for 600 persons, boxes, and dressing rooms

in arrangement, avoidance of noise, and perfect ventilation.

A larger amount of plumbing fixtures is usually provided for in synagogues than in churches, for the reason that some of the services of the Hebrews require the constant attendance in the place of worship during an entire day. This requires separate toilet-rooms for men and for women, for boys and for girls, in addition to drinking fountains. It may be here pointed out that in some of the older synagogues of some European cities there are special purifying baths for women provided, which are required by the religious rites of the orthodox Jews.

Many matters have in the preceding pages been merely hinted at, but it is believed that enough has been said to demonstrate that the health of congregations demands a proper attention to the subject of sanitation, and that indifference to church hygiene by those at the head of such institutions, must at the present day be considered inexcusable.

BIBLIOGRAPHY.

There are a few books on "Church Architecture," but none of them discuss the subject of "Sanitation." Inquiry among several publishers, failed to discover any American book on Church Hygiene. Neither are there available any German books on the subject.

SCHOOL SANITATION

IV

SCHOOL SANITATION

1. **Definition of Terms.**—School hygiene and school sanitation are not to be considered synonymous terms, for the former comprises a much wider range of subjects than the latter.

School *hygiene* deals with every possible aspect of school life, so far as the same may affect the health of the children; it includes subjects such as the periods of study, the care of the eyes of pupils, the posture of children in school, curricula of studies, methods of teaching, school discipline, medical school inspection, and school diseases.

School *sanitation*, on the other hand, refers to the school building only, to its location and construction, its equipment and sanitation. School hygiene is therefore a broader term than school sanitation.

The contents of this chapter will be restricted to the latter meaning, and will deal more particularly with the safety and sanitary features of school buildings. A brief resumé of some German maxims on school sanitation, which the author published some years ago, are substantially embodied in the pages of this chapter, and form the basis for the same.

2. School Sanitation.—Everything pertaining to general house sanitation is, of course, applicable to school sanitation, with this particular distinction, that in the case of school buildings we are providing for children whose bodies are in a process of growth and development and, for this reason, are perhaps more susceptible to outside causes tending to affect their health and also more subject to illness. Growing youth requires the best sanitary environment to guard it against illness, because defects in the construction, sanitation or equipment of schools may injure children for a long time, in some cases even for life.

The importance of sanitary school buildings for the bodily and mental improvement of children is being more and more appreciated. School houses differ from dwelling-houses in having a very large number of children congregated together for many hours each day, and this is another reason why the closest attention should be given, in the planning and construction of schools, to their sanitation. ventilation, and means for cleanliness. The largest school-houses, which sometimes hold from 1000 to 3000 children, present difficult and important hygienic and mechanical problems, which must be carefully dealt with.

This chapter treats of school buildings in general. It disregards entirely the usual sub-divisions of schools into primary, grammar, and high school; the classification into manual training schools, polytechnic schools, and other higher schools of learning, such as seminaries, colleges, and universities. Space also forbids dealing separately with the public and the private schools; with boys', girls', and co-educational schools.

I shall take up first the question of location and site of school buildings; and after that I shall discuss the building itself, its plan and construction, number of stories, its safety from fire and the disposition of the rooms. Next in order will be a consideration of the school-room proper; and following it, special subjects of interior mechanical equipment, comprising heating and ventilation, lighting, sanitary arrangements, water supply, school baths, outside sewerage, and sewage disposal will be discussed; finally there are questions of management, such as maintenance of cleanliness, sanitary inspections, together with some general sanitary considerations.

Location or Site.

3. **Choice of Site.**—The question of a choice of site for a building is always an important one, but for reasons above stated it is particularly so in the case of schoolhouses. The site for a school-building must be carefully chosen, and all possible drawbacks and disadvantages must be examined into or anticipated. The site should be elevated, reasonably level, though with sufficient slope on one or more sides, if possible, to facilitate good drainage; it should be open, airy, and dry. Regarding the size of a lot for school purposes, this should be large enough to allow the building to stand back from the street and to provide plenty of playground, open spaces, or yards with some shade trees.

4. **Area of School Grounds.**—The German standard provides an area of school grounds equivalent to three square meters for every child, and in England the standard seems to be about the same, namely 30 square feet. Thus, for a school intended to house 1000 pupils the lot should measure 30,000 square feet; in other words it should be about 300 by 100, or 150 by 200 feet. A large lot secures not only a recreation ground, generous in size, but it also provides for good lighting of the school rooms, as no over-shadowing from adjoining buildings can occur.

5. **Soil.**—A porous soil, such as sand or gravel, is the best. In all cases the ground should be well-drained and free from organic matter. No made ground or filled-in lot should be selected for school purposes. Swampy land is equally out of the question. The healthfulness of a school site is of so much importance that ordinary real estate considerations should under no circumstances govern the choice, and School Boards would do well, whenever they have to make a selection, to make it under the expert advice of a practical sanitarian.

6. **Surroundings.**—The surroundings of the schoolhouse are of the greatest importance, and hence the examination of a site should always include an inspection of the neighboring lots. Noisy surroundings or noxious manufactures should always be avoided. A school building should stand in a nearly central location in reference to the school population or the school district, but it should be placed away from noise, dust, soot, smoke, or polluted air. Hence it should not be placed

on a main city street, nor should it be located near industrial establishments, near a railroad depot or freight yard. The quiet side streets should be selected by preference. A school-house should never be built in the immediate vicinity of factories, smoke-creating establishments, noisy workshops, stables, hotels; military barracks, or markets, or near fire-engine houses, police stations, or hospitals. In a city a school-house should not be located adjoining a high building, as this would rob it of much necessary light. A street with noisy pavement should also be avoided, likewise filthy neighborhoods, or open and filthy yards which drain toward the school grounds.

In cities where the price of real estate is high, the choice of site is usually very much restricted, and sanitary requirements are difficult to comply with in the larger cities, where the selection often becomes very limited.

For country school buildings the neighborhood of swamps, or of stagnant water, should be avoided. The question of water supply and drainage form an important consideration when investigating a site. In rural districts a school-house is often found to be located at the outskirts of a village, this location being made necessary by reason of the requirement to place the school in the centre of the district.

7. **Aspect.**—Regarding the aspect of the school-house, the buildings should be so placed as to secure some sunlight for all rooms, for sunless rooms are apt to be damp and cheerless. In Germany, school-house buildings are placed as much as possible, with regards to the

points of the compass, so that the windows of the class-rooms will face the northeast or else the east. In case the rooms are located on both sides of a corridor, the windows are made to face northwest and southeast, and no windows are placed to the southwest. The latter aspect is only considered admissible for schools in which in the summer no teaching is done in the afternoon. A northerly aspect avoids the glaring sunlight during school hours, and while it is cold and bleak in winter, it is good for the lighting of the rooms and particularly good for drawing-rooms. As a rule, an easterly, southerly, or southeasterly exposure is preferred in the United States, and the westerly is considered to be the least desirable.

8. Trees on School Grounds.—If the lot permits of it, a school building should be set back on all sides so as to have a free air circulation, and so as to avoid the dust and noise of the street. Trees should never be nearer than 20 or 25 feet from the school building; if placed at a greater distance than mentioned, they are advantageous for they afford shelter from the sun on the playground, and also because they form the best obtainable ornamentation of the grounds.

9. Beautifying School Grounds.—In cities, the school grounds are generally so small as not to permit the planting of trees, but in country schools the cultivation of trees should always be encouraged. Suburban and country schools often have their grounds carefully laid out with grass plots, flower beds, and shade trees. Money used in making school grounds attractive and beautiful is always well spent, and where the school grounds are large a map of the same should be prepared and a number of trees located on the same, the trees being planted by the children on succeeding "arbor days." Such school yards form the best possible place for nature study; they teach the children the different kinds of trees and shrubs, and thus they learn at an early age how to care for them.

10. Playgrounds.—Playgrounds should be located on the sunny side of the building, and should be dry and sheltered from the winds. In the centre a pavilion should be provided, protected by being roofed over but kept open at the sides, for the use of the pupils in case of stormy weather. The yards should be kept dry and well drained. Cemented or flagged walks should lead to the principal entrances of the school, but otherwise the playgrounds should be finished with lawns or with soft clean gravel or cinders. In the case of city school-houses, located in congested districts, outside playgrounds cannot often be had, and in such a case a substitute may be arranged by providing playgrounds on the roof of the building.

The School Building.

According to Morrison, the essential general requirements of school buildings are: shelter, adequate space, good construction, lighting, heating, and ventilation, sanitation, suitable interior equipment, and chaste decoration.

11. Construction.—Regarding the construction of school-houses, it may be said, in general, that school-houses should be built of the best and most durable materials and of thorough and substantial workmanship. Next to good construction come the requirements of proper sanitation, adequate heating and ventilation and correct lighting. A well constructed building will in the end always prove economical, for the reason that in this class of buildings there is perhaps more wear and tear than in any other class. It would be exceeding the limits of this chapter to discuss in detail the construction of foundations, of exterior and partition walls, of ceiling, roofs, and chimneys.

12. **Safety from Fire.**—Security against fire should always be one of the chief considerations. Where so many children are congregated, the danger of fire or panic is always present and must be suitably guarded against. For this reason all school-houses, located in city streets, should be built of brick and of fire-resisting construction, for frame structures would be too much in danger of fire. Isolated school-houses in the country do not require brick or stone walls, but every possible precaution should be taken to make them at least slow-burning.

13. **Boiler Room.**—A school-house should always be provided with a basement or cellar under the entire building. In this the boiler and coal room are located, and also sometimes the play-grounds, lavatories, toilet-rooms, and school baths. The floor of the basement should be free from dampness, and be asphalted and made waterproof.

14. **Walls.**—All walls of class-rooms should be smoothly plastered and the lower part finished in hard plaster. Inside walls of corridors, toilet-rooms, cloak-rooms, etc., *may* be finished with enameled brick or tiles.

It is important that all cornices should be well rounded and that there should be no moldings or ledges to catch dust.

15. Ceilings and Floors.—The ceilings should be strong, fire-proof, and sound-proof, and the latter requirement is, of course, equally true of the floors. These should be stiff, constructed of an under floor of spruce, covered with narrow oak or other hardwood boards; the floors should be without vibration and with deafening between the joists. The floors should be either painted or well oiled. All corners between floors and walls should be finished with round coves. Wooden floors for basement rooms should be laid on sleepers, bedded in cement.

16. Entrances.—The entrances should have covers or large protected vestibules, where those children, who arrive early, may stand protected from the weather. Exposed entrance steps should be avoided, as they become dangerous in winter time, when covered with ice. The entrance doors should always open outward, as should also the doors of the class-rooms.

17. Corridors.—The corridors should not be too narrow, particularly when the pupils' wardrobes are located in them. A desirable width is from 10 to 12 feet. They should have floors of wood, covered with linoleum, or else the much better tile floors. All corridors should be properly heated and well lighted. Where class-rooms are located on both sides of a corridor, windows should be put at each end.

18. Staircases.—The chief requirements of the stairs are that they should be fireproof, strong, and safely built, well lighted and preferably enclosed by fire walls; the open well stairs should be avoided. There should be no winding steps and each long flight of stairs should be interrupted with at least one landing. There should be a rail on either side of the stairs and very wide stairs should have a centre rail. In large buildings there should always be at least two staircases.

19. **Exits.**—The corridors, stairs, exit doors, and exits should be planned so ample as to permit of the entire emptying of the school in from 3 to 4 minutes.

20. **Disposition of Class-rooms.**—The planning or the disposition of the rooms of the school building depends upon many considerations, and chiefly upon whether the building is to be erected for both boys and girls, or only for children of one sex.

In general, a symmetrical plan will be the best and there should be a corridor running the length of the building, with the classroom located at one or both sides of the same. There should be a sufficient number of staircases for the safe and quick exit of the children in case of a panic or fire.

21. **Number of Floors.**—The number of floors depends upon the requirements and on the number of pupils to be accommodated. It should be said, however, that buildings of more than three stories are not to be approved, for the stair climbing is injurious, particularly to the older girls, and there is always the danger of loss of life, in case of a panic or fire. In congested city districts, such as the east side of New York, one may of sheer necessity be obliged to put up a ten-story building, as recently planned, but on general principles such a plan can never be approved,

for even with the largest and safest elevators it is not clear how a school-house containing 5000 pupils could be emptied sufficiently quick in case of an outbreak of fire. It is bad enough to have a city made ugly by the erection of commercial monstrosities in the shape of skyscraping office buildings and hotels. Skyscraper schools are, in my judgment, hazardous and ill-conceived, and the proposition to erect them should be dismissed as impracticable and absolutely dangerous.

For suburban and country schools it is decidedly better to limit the number of stories to two or three, in which latter case the important class-rooms are located in the lower stories, whereas the top floor may contain the assembly hall, or may be used for a gymnasium, or for classes in manual and physical training.

22. **Basement.**—A high, well-lighted basement is essential; its clear height should never be less than from 10 to 12 feet. A well constructed basement, with windows half above the grade line, and with a proper air supply, should be as sanitary as any other part of the building. If the basement is dry and well lighted, a part of it can be used for recreation or playrooms, for cooking classes, for the gymnasium and for some school baths for children of both sexes. There should also be a janitor's workroom. The boiler and coal room floors should always be well cemented or finished with a brick pavement. These rooms should be enclosed with brick fire walls, and the doors should be stout wooden doors, lined on both sides with tin.

23. **Fire Escapes.**—In buildings of more than two stories, outside fire stairs, not merely fire ladders, should be

provided in addition to the inside staircases, but they must be properly designed and constructed, and should always be covered in from the weather so that they can be used by the children in times of danger.

24. **Sewerage.**—The building should be well sewered and drained. All plumbing should be the best obtainable, both in workmanship and in the character of the fixtures. Regarding its general arrangement, the same rules of drainage that are used for other buildings apply. In the city, the school-house should have connection with a city sewer, whereas for country school buildings, not within reach of a sewer, other safe and sanitary methods are now-a-days available, a brief reference to which will be made further on.

25. **Assembly and Special Rooms.**—In addition to the number of class-rooms required, there should be a large assembly-room, capable of seating the entire number of pupils, also teachers' rooms, an office for the principal, teachers' toilet-rooms and specially well-ventilated cloak-rooms for the pupils. The principal's room should be located central and convenient of access. Regarding the assembly-room, which is often located on the top floor, it has been suggested that the best position for the same is on the ground floor, in a central rear wing of the school. From the point of view of danger, in case of a panic, the suggestion deserves much consideration.

In high schools, provision should be made, besides class-rooms, for physical and chemical laboratories. They should be fitted up with numerous shelves and demonstration tables and should be piped for water, gas, steam, compressed air, and waste-pipes. In chemical laboratories, special gas-hoods with exhaust flues must be provided for the removal of noxious gases.

26. **Exterior of Building.**—The exterior of a building, devoted to the causes of education, should be well-proportioned, dignified but plain, and expressive of the character of the work for which it is erected. All needless and meaningless ornamentation of the building should be avoided. If some money is available for beautifying a school, I hold that it is preferable to spend it on inside decoration and for the improvement and beautifying or the grounds.

27. **Interior Decoration.**—Appropriate, simple, and refined decorations should be used to adorn the classrooms and the principal corridors. The walls should be rendered attractive by hanging on them some framed pictures, photographs, color prints, or photogravures of objects relating to history, the fine arts, the natural sciences or to landscapes. There should also be some good topographical or physical wall maps of the principal countries of the world, also a good-sized globe. A few plaster casts of well-known sculptures, some vases, and flower pots, a bookcase with choice books of reference, histories, cyclopedias,—all these help, more than anything else, to adorn the school interior.

Carpets, upholstered furniture, lace curtains, draperies or heavy portieres are out of place in a school, and objectionable from a sanitary point of view.

THE SCHOOL-ROOM.

28. Shape and Dimensions of Class-rooms.—The school-room forms the unit in planning a school building, much the same as a ward forms the unit in a hospital. A school building should be considered as a number of class-rooms, properly arranged and connected by means of the halls and stairs with the entrances and exits, rather than as a whole building cut up into a number of rooms. By this statement I mean to emphasize the fact that the shape and the dimensions of the school-room are all important, and that in order to attain perfection, it is necessary to determine these first, rather than to determine the size of the building and afterwards to leave it to chance to get class-rooms of a shape and size as they may happen to come.

Numerous attempts have been made, by writers on school sanitation, to determine the best dimensions for a class-room. A standard size necessarily depends upon numerous considerations, such as lighting, ventilation, heating, physical requirements, needs and capacities of children and teachers.

29. Standard Shape.—In general shape, a class-room should be oblong rather than square, and the desks should be so placed that the aisles between them run the long way, in other words, longer classes are better than wide classes. In the interest of the eye-sight and of the hearing of the scholars, and on the other hand of the lungs and vocal organs of the teachers it is advisable not to exceed certain maximum dimensions of length, width or depth and height. In the interest of the general control of discipline by the teachers it is likewise to be recommended to limit the sizes of rooms and the number of children in one class to about 45 pupils. Experienced teachers hold the view that a class of 50, 60, or even more pupils is very hard to control.

30. **Length.**—The length of a school room is best determined by the distance at which an ordinary voice can be clearly heard, and likewise by the distance at which ordinary blackboard writing can be seen by the normal eye of the pupil. This distance is variously assumed to be from 28 to 32 feet.

31. **Width.**—The width or depth of the room is also of much importance and depends primarily upon the height of the top of the windows, Assuming that daylight comes only from the left side of the pupil, German rules require that the depth should not exceed two and one-half times the height of the window top above the plane of the desks. In Europe, class-rooms are generally limited to 30 feet in length, in the United States to 32 feet and the width varies from 20 to 28 feet, depending somewhat upon the height. A good proportion between the length and the width of the room is from 3 to 2. The so-called long rooms, in which the proportion of length to width is as 4 to 3, and in which the desks stand parallel to the short sides of the room, are the most desirable from a sanitary point of view. Square rooms are only admissible in the case of a smaller number of scholars.

32. **Height.**—A certain minimum height is necessary in the interest of good ventilation and good lighting, and

this is fixed in Europe at about 3½ to 4 meters; in the United States the average height is from 13 to 13½ feet.

33. Floor Space.—There are two other important considerations regarding the proper ventilation and the avoidance of crowding in school-rooms, namely, the area of the floor space and the cubic space assigned to each pupil. Some rules require 15 square feet of floor space and 200 cubic feet of air space per pupil, and with a room 30 feet long, 25 feet wide, and 13 feet high, this would limit the number of pupils to 48. For 54 pupils a room should be 33 feet long, 25 feet wide, 13 feet high, giving 200 cubic feet and 16½ square feet to each pupil. The best United States schools provide 16 square feet and 216 cubic feet for each pupil. In Europe, the requirements of various governments are that there should be from .85 to 1.50 square meters (9 to 16 square feet) for each pupil.

34. Cubic Space.—Requirements, such as are usually made for hospitals, cannot be applied to class-rooms, and in consideration of the shorter space of time in which the pupils are confined in a class the cubic space is made smaller and is usually assumed at from 4 to 5 cubic metres (141 to 177 cubic feet) for small, and from 6 to 7 cubic metres (211 to 247 cubic feet) for older pupils.

35. Floors of Class-rooms.—A few more words should be said about the sanitary requirements of the floors, walls, and ceilings of the class-rooms. The floors should be free from dust and non-absorbent, and also good non-conductors of heat and sound. Hard wood floors are the best, but are necessarily expensive. As a rule, pine or spruce floors must be used, and should be finished smooth and stained or oiled.

36. Walls of Class-rooms.—The walls of a class-room should be of a light color so as to reflect light without causing any disagreeable glare. A light shade of blue, gray or green paint is the best and should be renewed frequently. The ceiling should be finished in a slightly lighter color than the walls. Plastered walls should be painted with oil colors at least to a height of six feet.

37. Doors.—All class-rooms should have the doors hung so as to open outward. Transoms should be provided over the doors.

38. Lighting by Windows.—Regarding the lighting of school-rooms by windows, the first requirement is that the windows should reach to nearly the ceiling and have nearly square tops; the second requirement is that the light should come principally from the left side of pupil. It is best to provide windows only on one side of a class-room, but some well-lighted school-rooms have been consructed which have windows on two sides at right angles. Windows on opposite sides of a room are always bad. A good rule is to provide at least .15 square meters (1.6 square feet or 233 square inches) of window surface for each pupil. Some authorities require from 300 to 350 square inches of window-glass for each pupil. Another rule frequently met with is that the windows should aggregate in area from $\frac{1}{4}$ to $\frac{1}{6}$ of the floor space of the room; but in many of the older schools this proportion is only as 1 in 10

Windows should be wide, with large panes, and with glass of good quality, and they should always reach to within six inches of the ceiling. Arched windows should be avoided, because they reduce the area of the upper part of windows, which from the point of view of lighting is of the greatest importance. Some recommend spacing the windows close together, with large piers at the end of the room, while others prefer an even distribution, in which case the piers should be kept as narrow as possible. The lower half of the window sash should have frosted or opaque glass and the window-sills should be placed from 4 to 5 feet above the floor. Where a school-house is not set back from the building line, the lighting of the rooms will depend much upon the width of the street and the height of buildings on the opposite side.

39. Direction of Light—Position of Windows.—Regarding the direction, from which the light should come, all authorities are agreed that it should not come from the front or the right. Authorities are also agreed that it is best that it should come from the left, but as to light coming from the rear various writers seem to differ. Light from behind is not quite as bad as right-hand light, but in the interest of the teacher, who would have to face such windows, it cannot be recommended. Light from directly in front is very disagreeable, trying and injurious to the eyes, whereas the light from the left side seems to be free from disadvantages. Light directly from above is particularly suitable for drawing-rooms and for laboratories.

This question of the proper lighting of school-rooms is one which it is impossible to go into at great length in the space of a single chapter, but it is of the greatest importance for the healthy maintenance of the eyesight of the pupils. In Germany it has been proven, by numerous examinations of pupils' eyes, that nearsightedness is of frequent occurrence in schools, also that it increases in frequency and in degree in the higher classes.

Wall maps, drawings, and charts should be so hung that they may be visible from every seat in the class. Children, whose eyesight is defective, should be given seats in the front rows of desks. Reading and writing, during twilight or on dark days, when the class-room is insufficiently lighted, should be avoided. Those lessons which require much use of the eyes, should be given during the lightest hours of the day.

40. **Window Shades.**—The windows should be provided with curtains or shades, which intercept and moderate the direct sunlight or a strong reflected light, both of which are injurious to the eyes. Roller shades are best arranged so as to roll both from the top down and from the bottom up. The color of the shades should not be too dark, and it is found that a light buff or cream color is the best.

41. **Blackboards.**—The blackboards should have good light, and must have a perfectly black dull surface without any gloss.

42. **School Seats and Desks.**—Another subject of paramount importance is the proper seating, the proper position of the bodies of the children, and the correct distance of the eye from the writing or reading book.

With this in view, numerous types of hygienic school desks and seats have been advocated. At the Hygienic Exhibition of 1883 at Berlin, more than 70 models were exhibited. Seats and desks of different sizes and heights are provided in the classes to accommodate pupils of varying size. A bad posture may ultimately lead to permanent lateral curvature of the spine, or cause impairment of the eyesight. A cramped position will tend to injure the chest, lungs, and the abdominal organs. All school desks should be designed with slope and so built that they may be readily cleaned. There is no question that single desks and single seats, which is the prevailing system in American schools, are the best, and they should always be provided where economy in space or in cost of equipment does not forbid them. The seats should be placed as near as possible to the windows; the distance of the farthest seat should not be more than two or two and one-half times the height of the top of window above the desk level.

43. **Wardrobes.**—It is necessary, for the preservation of order, to provide wardrobes, or coat rooms, in which the pupils may keep their overcoats, hats, rubber shoes, and umbrellas. These should always be lighted, warmed, well ventilated and have the walls finished in some non-absorbent material, suitable for cleaning and disinfection. The cloak-rooms should have hooks for coats and hats, shelves for rubbers, and racks for umbrellas, with troughs for the drippings.

It is best if a separate cloak-room is provided for each class, though limited floor space often prevents such an arrangement. The wardrobes may be arranged inside of the class-room, but this is a decidedly bad practice, or else they may be placed in the corridors, or in large closets or cloak-rooms adjoining the class-rooms, which latter forms the best arrangement. It is not generally considered advisable to provide one congregate wardrobe for the entire school in the basement.

44. **Accident Room.**—In large schools it is advisable to reserve a small room as an accident room, in which children which are suddenly taken sick may be kept until they recover or until they can be sent home.

Teachers should be made familiar with the measures to be taken in case of accidents, injuries, or sudden illness. The principal should see that each school is provided with a surgical emergency case, containing the most necessary articles for rendering first aid to the injured. Printed directions of what to do—and what not to do—in case of emergency, until the surgeon's or physician's arrival, should be conspicuously hung up in every school-house.

Heating and Ventilation.

45. **Systems of Heating.**—The method of warming a school-house is determined primarily by the number of rooms to be heated; it is likewise dependent upon considerations of convenience and economy.

As is well known, we may distinguish in general between *individual* or separate, and *central* or general, systems of heating. The separate heating is accomplished by means of stoves placed in each of the class-rooms, whereas in central heating we deal with only one or several fires located centrally in the cellar or basement. In the latter case, the system of heating may be either by means of warm-air furnaces, or by steam or hot water, and in these again the heating may be either by the direct or by the indirect method. The danger from fire increases in a building with the number of fires required for warming, hence the concentration of the heating apparatus in one place is much to be preferred.

46. **Heating by Stoves.**—The local heating of schoolrooms is practically carried out only in the case of the smallest country school houses having only a few rooms; in such buildings the method is economical, because the first cost of a number of stoves is much less than the outlay for a central plant, but on the other hand there are a number of drawbacks, amongst which are the attendance which the many fires require, the bringing in of the fuel and the incidental disturbance of the lessons, the space required by the stoves in the class-rooms, the dirt, which comes with the ashes and soot, and the difficulty of introducing pure air. Heating by gas stoves has been tried to a considerable extent in Germany, and while it is very cleanly and convenient, it necessarily costs from 40 to 50% more in fuel than heating by wood or coal.

47. **Furnace Heating.**—For buildings having from 4 to 8 rooms, furnace heating is the usual method. It is a method which is cheap and which can be made sanitary if a proper air supply and cold air box are provided, and if attention is given to the degree of humidity in the air. The furnaces must be large enough so they do not overheat the air, rendering it dry and unbreathable.

In the better systems, special mixing dampers are provided, so that the air can be tempered at will from the class-rooms in case of mild weather, without the necessity of shutting off the fresh air supply entirely. The limitations of furnaces are caused by the fact that warm air will not readily travel horizontally for long distances, and that during windy and cold weather an unequal distribution of heat results, owing to the fact that some of the hot-air flues will act better than others.

48. **Steam Heating.**—Where a school-house contains more than 8 rooms, a steam plant begins to show substantial advantages. The heating should be accomplished with low pressure steam and preferably by indirect radiation, which involves the placing of a sufficient number of heat-radiating stacks at the bottom of the warm-air flues. Fresh air conduits should be provided which supply these heating stacks and the air should be drawn from pure outdoor sources. Well designed, indirect low-pressure steamheating systems have proven very satisfactory. Thermostatic control of the temperature of the air in the class-rooms is much to be desired.

49. **Hot-water Heating.**—Indirect hot-water heating is a very excellent system, but it costs more than steam-heating and is not used to the same extent. The precaution should always be observed not to cause the class-rooms to be overheated; it is usually recommended to consider from 66 to 68 degrees Fahr. as the maximum allowable temperature. The corridors, stairs, and wardrobes should likewise be moderately heated.

50. **Heating System to be Designed by Experts.**—I cannot do better than to quote from the able treatise by

Mr. Edmund M. Wheelwright, of Boston, on "School Architecture," the following paragraph referring to this subject:

"An architect should be expected to so plan a building that radical changes in construction are not required to admit the satisfactory installation of a system for heating and ventilation; but few architects have had the technical training, coupled with the special experience, which warrants them in designing such a system without consultation with an engineer whose interest in the work is not commercial. Where a system has been almost paralleled in a former building, constructed with such expert assistance, an experienced architect, if he has an honest and competent contractor, may accomplish a fairly good result; but, even under such conditions the work would generally be brought to a nicer conclusion if an expert were employed.

"Where a competent expert makes the plans and specifications and supervises the construction of such a system, all competitors for the work are put upon an equal footing; and the expert's compensation will be off-set to the owner, if not by the first cost, certainly by the greater economy in running and maintaining the plant, and its greater efficiency above that of a system installed by the lowest commercial bidder who uses his own plans and specifications. Expert service is rendered primarily for the client's benefit and if the client is unwilling to pay for such service, the choice of a system based upon commercial competition is all that he can fairly expect his architect to furnish."*

Not only should the heating apparatus for a large school be designed by an expert engineer, but the steam boilers should be managed by a trained engineer assisted by experienced firemen.

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* The plea, so forcefully presented in the above quotation by a well-known architect in favor of expert engineering services, is also applicable in its entirety to the *sanitary* and *hydraulic* installation of schools as well as of other buildings.

51. Ventilation.—The proper and ample ventilation of the class-rooms is one of the essential requirements of school sanitation. It is a sanitary problem of prime importance, but being so closely connected with heating, the ventilating system is usually designed or carried out by heating engineers. Ventilation is accomplished both by natural and by artificial methods.

52. Air Flushing.—Whether artificial systems of ventilation are provided or not, it is always desirable that each room should be flushed with pure air just before the school commences and also during each recesss. During the recitations windows should be kept closed to exclude the street noise and to prevent dangerous draughts on the pupils. All scholars should leave the class after the lessons and then the windows and doors should be opened for a few minutes and, this should be done not only in the summer time but in the winter as well.

53. Requirements as Regards Air Supply.—During the school hours the air of the room should be changed several times per hour; here it is where the requirements of sanitation sometimes conflict with those of economy in construction and in management of the heating apparatus. It is suggested by sanitarians that 2000 cubic feet of fresh pure air should be supplied to each pupil per hour, and in Massachusetts the requirement specifies 1800 cubic feet. This large volume of air must be taken from a pure source at an intake, located preferably at a point several feet above the ground, away from the dust of the street and not too near the toilet-rooms. The air should never be taken from the cellar. The fresh air must be suitably warmed in winter time and be distributed uniformly throughout the class-rooms in such a way that no annoying drafts will occur. In the best ventilated schools the fresh air is suitably filtered before being warmed.

54. Removal of Sources of Air Contamination.—All sources of air contamination within the class-rooms should be avoided or removed. This is all-important and without this measure the best ventilating system may be a failure. This requirement involves the placing of school wardrobes for the outer garments, as stated heretofore, outside of the class-rooms. I shall point out, in speaking of school baths, that unclean bodies and unwashed undergarments are among the most fruitful sources of bad air, and hence it follows that nothing will tend more to secure ventilation in the class-rooms, than to arrange a number of school baths and to give the children the opportunity, alternately to derive the benefits incident thereto.

55. Removal of Foul Air.—In ventilation it is not sufficient to introduce pure air in ample quantities, but the foul air of the room must be constantly removed. This is accomplished in school-houses either by natural means, such as the difference of temperature between the exhaust flues and the outer air, or else by means of mechanical appliances, such as exhaust fans. This is not the place to discuss in detail the subject of the plenum and vacuum systems of ventilation. Ventilation by means of mechanical appliances is always expensive, as it calls for an elaborate system which would doubtless secure the very best of results, but it is believed that in most cases the satisfactory ventilation of class-rooms can be accomplished by means of ventilaating flues artificially heated to create a constant draft.

56. Ventilation of Toilet-rooms.—The ventilation of the toilet-rooms is of particular importance, and the exhaust drafts for these should be sufficiently strong to insure that the air from the water-closets and urinal fixtures will at no time pass into other parts of the school.

57. Air Moistening and Temperature Control.—Regarding the humidity of the air in the school room, this should not be less than 40, nor more than 60 per cent. Where class-rooms are heated by a central heating apparatus, provision can be made for adding a certain percentage of moisture to the air before the same is conducted to the rooms, and in the case of individual heating appliances set up in the class-rooms, it is easy to provide special vessels containing water to be evaporated so as to prevent the air from becoming too dry.

Where a thermostatic system of temperature control is not provided for, it is necessary that every schoolroom should have a reliable thermometer. This, if possible, should be arranged so as to be read from the corridor as well as from the class-room, for in this way the janitor in charge of the heating apparatus may take observations of the temperature without disturbing the classes.

Lighting.

58. Daylight Illumination.—In speaking of the windows of class-rooms, I have already pointed out the means for their natural or daylight illumination. It is very desirable that the plan of the school studies should be so arranged that the more important lessons are given during daylight, and those lessons which require much use of the eyes, such as drawing and writing, should always be given during the lightest hours of the day. All seats of the class-rooms should have ample light. The halls, the stairs, the entrances, and the toilet-rooms should likewise be well lighted in day time to secure orderly traffic and a cleanly use of the rooms. It is impossible, however, to get along entirely without artificial light in the schools, and this will be required not only in winter time, but also at other seasons when there are foggy or cloudy days. Hence all city school buildings should be piped for gas and wired for electric lighting.

59. **Artificial Illumination.**—Amongst the chief requirements, formulated by sanitarians, for artificial illumination I mention the following, which are applicable to school-rooms as well as to other buildings: each desk or table should have ample light; there should not be any injurious or disturbing shadows; the light should not flicker; it should not be blinding to the eyes; it should not give off too much heat, and it should also vitiate the air of the apartments as little as possible.

60. **Electric Light.**—The best artificial light, available at the present day, is the electric light, and in particular the indirect reflected incandescent light. One of its chief advantages is that it does not give off injurious products of combustion as is the case with gas, oil lamps, or candles, but even the electric incandescent

light must be shaded by opaque or frosted globes, in order not to be too trying to the eyes. There is no question that the lighting of a school-room is better if accomplished by indirectly reflected light from clusters of lights placed out of the reach of children's eyes and provided with strong and suitable reflectors. The electric light is also much safer from the point of view of fire than open flames.

61. Gas Light.—Where gas illumination is necessarily used, it is recommended not to use ordinary flat flame burners, except in halls and in stairways. For the class-rooms, the round burners with chimneys and globes are preferable, but still better than these are the now well-known incandescent gas lights, such as the Welsbach light and others, which give more light, save gas, and give off less heat. It is found advantageous to surround these with suitable glass globes, and of the latter the scientifically constructed Holophane gas globes deserve to be recommended above all others.

62. Oil Lamps and Candles.—It is not necessary to consider the lighting by means of oil lamps or by candles, as this seems to be out of the question in a modern school-house. Such means of illumination can only be contemplated in the case of the smaller rural schools, or for emergency lighting, when the electric current or the gas supply are temporarily cut off.

Fire Protection.

Outbreaks of fires in schools are of frequent occurrence. It is, therefore, all-important that in the construction of the building no point should be overlooked which would tend to increase the safety of the structure. When the lives of hundreds of school children, many of a tender age, may be imperilled, everything should be done to avoid a dire calamity.

63. Fire Protection Apparatus.—Every school should be equipped with some good fire fighting apparatus. There should be fire stand-pipes with valves and fire hose in the corridors of every floor. There should also be available some portable extinguishers and fire pails. The school should have a fire-alarm gong, and telephonic communication from the principal's office to the nearest fire-engine station. The children should be taught how to behave in case of an alarm, and fire-drills should be held by the teachers at frequent intervals. Above all, it is important to provide plenty of safe exits, doors which open outward, at least two independent, well-lighted stairs with strong balusters, and with centre rails, where the width is more than four and one-half feet.*

SANITARY ARRANGEMENTS.

64. Location of Toilet-rooms.—A question of much sanitary importance in connection with school-houses is the location of the toilet-rooms or "sanitaries" for the pupils. Shall these be located within or outside of the school-house? Another question is whether, in a large school, the toilet-rooms should be relegated to the basement, or whether there should be one or two on each of the principal floors.

The author cannot agree with those who, doubtless

* See Appendix A.

with the best of intentions, claim that the toilet-rooms for school children should never be in the basement of a school-house, and who argue that the sanitary conveniences should be placed in a detached pavilion, connected with the main building by a covered passage-way.

65. Objections to Outside Toilet Pavilions.—There are several objections to such outside toilet-pavilions, one of which is that they are difficult to heat in winter time; another is that it seems almost impossible to ventilate the apartments as well as the plumbing pipes through the roof of such one-story structures without causing annoyance and offense by reason of such vent flues and soil-pipes opening below the class-room windows. It is, of course, possible and practicable to draw both the vent flues and the soil-pipes over to the main buildings, and to extend them upwards to the highest part of the roof, and to thereby avoid any escape of noxious air into the windows of the class-rooms, but such a construction is usually complicated and always expensive.

66. Basement Toilet-rooms.—Given a good dry basement, with proper facilities for water supply and sewerage, the author cannot find any valid objection to locating toilet-rooms directly in the basement of a school, provided that he can be assured of the good and positive ventilation of such apartments. That this can be accomplished in the present state of the art of ventilation, cannot be doubted for a moment. Of course, where toilet-rooms are so located, it is absolutely essential that there should be safe sanitary plumbing work, but this also, in the present state of the art of draining buildings, can be attained. The author, however, would make one more restriction, and that is, that in basement toilet-rooms the water-closet fixtures used should be the single or individual closet bowls provided with the best of flushing arrangements.

67. Water-closet Fixtures Suitable for Schools.—Either short hoppers, pedestal wash-down closets, or siphon closets should be used. The flush is sometimes arranged to work automatically, but this involves a large waste of water; it is better to provide individual chain-pulls. The so-called range closets should never be used in the basement of a school, and it is a grave mistake, sometimes met with, to consider such latrines superior to individual closets for schools. Where dry earth closets are necessarily used on account of a lack of sewerage or water supply, these also should be located in an outer pavilion.

68. Toilet-rooms for Upper Floors.—In very large schools it is a good plan to provide on every floor toilet-room conveniences, which should then be located in separate well-ventilated wings or towers. A few school authorities, indeed, claim that this makes the most desirable arrangement. It would doubtless be advantageous in saving much time of pupils which is otherwise unnecessarily wasted. Ease of access and complete isolation are the two principal requirements regarding location.

69. Teachers' Toilets.—In all school-houses there should be on each floor at least one toilet-room for the teachers' use, though there appears to be some wisdom in the plan of arranging for a separate teachers' closet in each of the basement toilet-rooms, in order to have these apartments under constant control of the teachers.

70. Number of Water-closets Required for Pupils.—As to the number of seats required, it is usual to provide in a school one water-closet for 25 boys and one seat for every 15 girls. The water-closet apparatus should be durable and strong in construction; it should be simple and positive in action for it is often liable to be unintelligently used or even abused. For the use of the smaller children, it is quite common now to provide closets with lower bowls and seats.

71. Floors, Walls and Partitions of Toilet-rooms.—The floors of toilet-rooms, should always be made waterproof and provided with one or more floor drains, so as to enable the janitor to wash the entire apartment by means of a hose. Small, unglazed, hard white tiles make an excellent toilet-room floor. The walls should be either tiled, or of enamel brick, or of common brick, enamel painted. The partitions should not be of wood, but of either soap-stone, slate, or opaque glass. It is usual to provide doors to each compartment on the side for girls, but on the boys' side they may be omitted. If doors are used in connection with water-closets, they should never be run to the floor. They should be cut off at least eight inches above the floor and the doors should be light screen doors hung with spring or reverse hinges.

72. Water-closet Ranges.—If an outside water-closet pavilion is arranged, the water-closets may be enameled iron or porcelain combination ranges with automatic flush. Such fixtures are somewhat cheaper than individual water-closets. Some of them are good, while a great many are bad, and all are very wasteful of water. To limit the flushing of such ranges to the operation of the janitor, whose many duties may often compel him to neglect this, would be an unwise proceeding. All trough closets with continuous bowl and intermittent flush cause some pollution of the air of the apartment; those trough closets, which have separate bowls attached to a common bottom conduit, are therefore preferable.

All school closets should be inspected at least once a week by the principal of the school.

73. **Dry Closets.**—If dry closets are used in outside buildings, owing to the impossibility of providing sewerage facilities, the arrangement for drying the excreta and the ventilation of the closets should never be connected in any way with that of the class-rooms.

74. **Outside Closets for Country Schools.**—In country schools, all outside privies or dry closets should be frequently disinfected; compared with water-closets, even the best of them appear at times offensive. Outhouses for country schools should never be closer than fifty feet to the main school building. They should be made inconspicuous, but preferably connected with the school by a protected walk. Good lighting is as essential for these as it is for the water-closet rooms.

75. **Boys' Urinals.**—Among the most important fixtures in the sanitary equipment of school-houses are the boys' urinals. It is a most difficult matter to maintain these in a good sanitary condition. In determining the number of stalls, it is usual to allow one stall for 15 boys. The construction and arrangement of the

stalls require careful consideration and attention to details. The width of the stalls should be from 18″ to 20″, and the depth of the partitions from the front to the wall should be from 15″ to 18″. Partitions for the stalls should be provided for, but should never reach down to the floor; the height should be from 4 to 5 feet.

76. Material for Urinals.—Regarding the material used for urinals, it may be said that all materials which corrode, disintegrate, or which are absorbent, are absolutely unfit and out of the question, hence the wooden partitions so often found in the urinals of school-houses, and the slatted wooden platforms to stand on, are to be entirely condemned. It should likewise be pointed out that many kinds of marble and cement in any form are absorbent and therefore unfit, and that metals, with the single exception of white-enameled iron, are also out of place. The only materials which wear well and which are fit from a sanitary point of view are slate, Alberene stone, hammered glass, and solid glazed porcelain ware.

77. Types of School Urinals.—Of the three types of urinals, namely, the individual bowl urinals, the trough urinals, and the floor gutter urinals, only the latter kind can be recommended for use in school-houses. The trough urinal is inferior because it requires in addition to the trough a trapped floor gutter, which must be flushed, hence it seems wise to dispense entirely with the trough.

The backs, the ends, and the partitions may be made of either hammered glass, rendered opaque, or of slate or Alberene stone; the floor gutter and the platform are made of slate or Alberene stone. Where pieces of slate are bolted to the wall, this should be done with brass bolts to avoid corrosion. The entire back wall of the urinal should be thoroughly flushed by means of a perforated brass pipe supplied from the intermittent flushing tank.

In the author's judgment, the best urinals for use in schools are the solid white porcelain niche urinals, supplied with abundant flush from solid earthenware flushing-tanks. These are somewhat expensive, and next best in order are gutter urinals of slate or of Alberene stone.

In all cases it is important that the floor in front of the urinals should have a good slope towards the fixtures. In addition to this, it is to be recommended to have for the urinals special local ventilation to an aspirating shaft; it may be arranged either from the house side of the trap or else through hollow spaces at the rear of the back wall. It is also essential that such fixtures should be cleaned daily by the janitor to avoid unpleasant smells.

78. Care of Toilet-rooms.—All toilet-rooms and their fixtures should be well taken care of and should be constantly controlled and watched by the janitor. The use of disinfectants should not be encouraged. Where a good type of flushing water-closet is used, and where a good water-carriage system of sewerage exists, disinfection is not ordinarily required. As a rule, any deodorant which may be applied, simply substitutes one odor for another. It is very much better to maintain perfect cleanliness and perfect ventilation, and that this is as feasible in a school building as in a hotel toilet-room cannot at this date be doubted.

79. Drinking Fountains.—School children should have, during recess, an opportunity of drinking water; this should be provided in ample quantity and of good quality. In city schools, the supply is best taken from the public or street supply. Where such is not available, as in the case of country schools, a driven or tubular well should be provided, in preference to a dug or shallow well.

The water yielded by the well should be subjected to a periodical biological and chemical analysis. Where any doubt exists as to the character or wholesomeness of the water it would be well to provide a Berkefeld, or other equally good, filter, though in cases where contagious illness exists it is preferable to boil and subsequently cool the drinking water.

Water-buckets with two or more drinking-cups for dipping into the bucket are an abomination; not much better are sinks for drinking water with common cups, for they often constitute the means of transmitting discase, such as tonsillitis or diphtheria. Where running water is available, the modern hygienic drinking fountains with flowing jets are much to be preferred.

80. Lavatories.—In every school there should be provided some wash-basins, or wash-sinks, adjoining, but not in, the toilet-rooms; by the use of these the children are encouraged in habits of cleanliness and decency.

81. School Baths.—The movement of providing in the schools free baths for children originated in the schools of Germany not long ago. The advantages urged became at once so apparent that the movement spread rapidly to other European countries, and shortly afterwards to the United States. At the present day school baths form in many of our large cities a most important addition to the sanitary school equipment.*

82. Forms of Baths.—In England, school baths are generally provided in the form of swimming-tanks or pools; these are intended for physical exercise and for health improvement. Such swimming baths are expensive to construct and to maintain and they invariably require, as a sanitary condition *sine qua non*, that there should be preliminary cleansing baths in the form of showers, otherwise the children would be exposed to the now recognized danger of the transmission of disease. The common bath-tubs are equally objectionable in a school. The only form which has any merits as regards schools, is the modern rain-bath. This is cheaper in first cost as well as in maintenance than all other forms of baths; it is also the form of bath best adapted for schools because it requires less room to fit up and does not use a large quantity of water.

83. Advantages of Rain-baths.—Such school rain-baths educate the children in bodily cleanliness and, incidentally, they invigorate the bodily system. The results, wherever school baths have been installed, have been universally satisfactory, and their good influence usually extends beyond the sphere of the school. In the large cities many children formerly came to school in a condition which made them unfit to associate with

* See W. P. Gerhard, "Modern Baths and Bath Houses." 1907. *John Wiley & Sons,* Publishers.

other children, and this for the reason that at home they had no opportunity for a bath. One very important advantage derived from school baths is this, that a much better ventilation is secured in the class-rooms because of the doing away with the once so prevalent smell of uncleanliness of body and clothing, the so-called "school smell."

In the public schools all children should be encouraged to take these baths, except where they are specially exempted by request of their parents or their physicians. In Germany the taking of the baths is voluntary, yet from 75–90% of the pupils bathe regularly, and the baths are quite popular, even with the girls. The teacher should have the right to require the taking of a bath in special cases. It is found by experience that the bath interferes but very little with the course of studies. Each child should take a bath at an average of once a week, but in summer time more frequent bathing is desirable. Doubtless the larger boys prefer a swimming pool to the douche bath, but the former is a too expensive form of bath and certainly not the right form of bath to provide in a school. There appears also to be no reason why all boys, who love physical exercise, should not supplement the use of the rain-bath in the school in summer time with frequent outdoor bathing in the river or in the ocean.

84. Details of Construction of School Rain-baths.—Regarding the details of the construction and fitting up of school baths, it should be said that the simpler the apparatus the better, but in all cases it should be constructed of unusually strong and well-wearing materials.

The bath compartment may be arranged singly, and this is required for the older girls; in other cases the room is arranged for the congregate bathing of a number of children. Where enclosures are used, partitions of Alberene stone, of slate, marble, or white opaque glass should be fitted up.

The best form of douche head is the one which stands inclined under an angle so that the bather will not wet his head, except he places the same purposely under the douche.

The baths are usually located in the basement, near the playrooms. The whole subject of school baths has been discussed by the author at greater length in a paper entitled "A Plea for Rain-baths in the Public Schools," presented at a meeting of the American Social Science Association, and published in the *Journal of Social Science* for 1900.

85. Sewerage.—The quick removal of sewage from a school building is of the greatest importance. In city schools, located on a sewered street, there is, as a rule, no difficulty in providing efficient sewerage, for, unlike the modern tall buildings, a school-house does not usually reach with its cellar floor below the level of the sewer in the street, hence the general rules on house drainage can be at once applied to school plumbing and drainage, and it does not seem necessary, in this chapter, to go over the grounds thoroughly covered by other publications of the writer.*

From a point ten feet outside of the foundation walls, the school sewer may be of glazed vitrified sewer-pipe,

* *See the author's* works on Plumbing, House Drainage, etc.

but from this point towards the inside and within the cellar, the house sewer if located below the floor should consist of heavy cast-iron with caulked hub joints or with packed flanged joints, and when located above the floor of galvanized screw-jointed iron pipe.

86. Sewage Disposal.—For country schools, the disposition of the sewage often presents difficult problems. Two rules may be laid down at the outset, namely, first, common privy vaults should be entirely prohibited, and second, cesspools should be avoided as much as possible. If they must be used, because no other system seems practically available for the disposal of the liquid wastes, water-tight cesspools, built in two compartments, and located in the farthest corner of the school lot, should be adopted.

For smaller country school buildings it seems advisable to restrict the inside plumbing work to wash-basins and sinks, and to provide outside detached pavilions containing dry-earth closets. These should be closely watched in order to maintain them in a sanitary condition.

Wherever plenty of grounds are available about a school-house, the necessity of adopting the cesspool system does not exist and better systems of sewage disposal are available, which are discussed by the author in some of his other works.* It may suffice to mention that in many cases it is possible to dispose of the sewage

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* See W. P. Gerhard, "The Disposal of Household Wastes;" Van Nostrand Co.'s "Science Series" No. 97; W. P. Gerhard, "Sanitary Engineering of Buildings;" W. P. Gerhard, "The Sanitation, Water-supply, and Sewage Disposal of Country Houses." D. Van Nostrand Co., 1907.

by means of a local purification system, such as a disposal by sub-surface irrigation. A surface disposal may often be successfully installed, but this should never be done at a distance closer than 300 feet from a building. In other cases, finally, the sewage may be purified by means of bacterial action, either in septic tanks or in contact filter-beds, or preferably in a combination of both systems. By means of these systems, the sewage will be so purified that the outflow from the filter-beds may be discharged into a ravine or into some available water course, without annoyance to sight or smell, or without any appreciable contamination of the stream.

Maintenance of Cleanliness.

87. Care of Class-rooms.—The care of a school building is a matter of considerable moment. Class-rooms, corridors, and toilet-rooms must be kept at all times scrupulously clean. When it is considered that the cleaning is generally entrusted to the school janitor, it becomes apparent that the selection of the individual for the post of custodian of the building should be made with great care.

88. School Janitors.—Many so-called "janitors" are merely political appointees and lack the proper qualifications for their position, and the best planned and equipped schools will suffer through their incompetency. The work of the school janitor should always be under the control of the school principal, and the Board of Education should exercise a vigorous supervision of all school janitors. It is also important that a school janitor should not be so burdened with other duties that he would fail to find sufficient time to attend to the cleaning of the school-house. School Boards should recognize that, in a large school-house, the work of looking after the heating apparatus, the school baths, the toilet-rooms, the ventilating apparatus, the cleaning of the class-rooms, requires the time of several individuals. Therefore sufficient help should always be allowed to the janitor.

89. Daily Cleaning.—We may distinguish between the necessary daily cleaning and the periodical cleaning. The entrances, staircases, corridors, and cloak-rooms receive a great amount of outside dirt, brought in by the pupils, and therefore they should be scrubbed and swept daily. The school-rooms likewise should receive a daily cleaning at the close of the school day. All windows in class-rooms should be opened for the airing of the rooms and the floors should be swept. This should never be done when the floors are dry, but they must be sprinkled with wet sawdust, or similar damp material, or they should be swept with a wet broom, or with moist rags or mops. It is recommended to use for dampening a disinfecting solution, such as formalin. The school furniture, the desks, and seats should also be rubbed daily with a damp dust cloth. Regarding the proper way of dusting and sweeping, a recent occurrence in the New York School Board is of more than passing interest.

School principal B. had tried for many months to force his janitors to adopt *hygienic methods of school cleaning.* He demanded that they use wet sawdust in sweeping, and that they dust with damp cloths. The janitors preferred the feather duster, Mr. B. claimed rightly that the feather dusters were useful in stirring up germs from desks and seats, but was ordered by the Committee on Care of Buildings, to procure feather dusters for the janitors. He refused to do this. Called before the school Committee, Mr. B. argued that germs of measles, diphtheria, scarlet fever, etc., are much more liable to be removed by sweeping with wet sawdust and by dusting with rags made damp by immersion in a proper disinfecting solution. The story goes on to say that the Committee was deeply impressed by his suggestions, but they concluded that the method suggested would require the doubling of the number of cleaners. They gave no reasons for such a conclusion.

A great deal of dust is stirred up by the gymnastic exercise of the pupils, and therefore the gymnasuim should also receive a daily cleaning. Finally, the toilet-rooms should be looked after and, where they are made of impervious and smooth materials, the walls and the floors should be washed each day with a hose. With well-ventilated and well-flushed fixtures the frequent use of disinfectants in connection with plumbing should be discouraged as being unnecessary. It is much more important to strive for the maintenance of absolute cleanliness. As a rule, the deodorants commonly used only substitute one odor for another.

90. Periodical Cleaning.—The dust which accumulates in a school-house, and particularly in class-rooms, may be the means of propagating contagious diseases. For this reason a periodical cleaning at frequent intervals should be carried out in addition to the daily cleaning. Quite recently mechanical means for cleaning have been introduced in apartments and hotels, and in Boston the experiment is being made of installing a vacuum sweeping system in one of the public schools. Such a method, although costly, is doubtless efficient. At least once a week it is desirable to wash and clean the walls, as well as the window sills and the picture mouldings, if such are provided; the blackboards also should receive attention and the windows should be washed and made perfectly clean and bright. Once a month or oftener the cleaning of windows should be done, in order to admit as much light to the class-rooms as possible.

91. **Disinfection.**—During vacation time a much more thorough cleaning of the entire building should be arranged for; this should comprise both the cleaning and washing of walls and floors with hot water and soap and a disinfection of the premises. This disinfection should include the class-rooms and the warm air flues of the heating apparatus, also the cold air receiving-chamber and the air-filtering room.

The books and the pencils used in the class-rooms should be disinfected at least four times a year by means of formaline disinfection, and the floors and baseboards, desks, and seats should be washed not only with hot water and soap, but also with a disinfecting solution.

92. **Dust and Rubbish.**—In order to prevent as much as possible the wholesale accumulation of dust and rubbish, it is important that the overcoats and rubber shoes of pupils should be hung up in wardrobes outside of the class-rooms. Near the entrances provision should always be made, by shoe scrapers, for the cleaning of the shoes. Metallic door-mats should also be provided. Teachers should strictly enforce the rule that no spitting on the floor should be permitted.

Sanitary Inspections and Tests of Plumbing.

93. **Sanitary Inspections.**—It is of the greatest importance in a school-house that the plumbing, even when it is confined to the toilet-rooms, should be absolutely tight and that there should be at no time an escape of sewer air. To insure this it is necessary that the building should be tested and inspected periodically, and I might add that such tests and inspections should always be made by disinterested professional men. The form of inspection and the test to be applied would not essentially vary from those used in the sanitary inspection of other classes of buildings. It is usual, nowadays, to test the plumbing with a smoke machine. A sanitary examination should always include, besides the plumbing and drainage, a report on the general cleanliness maintained in class-rooms, cloak-rooms, basement, and school yards.

Some General Sanitary Conditions.

94. **Medical Inspections.**—At all times it is necessary to observe precautions against the spread of communicable diseases amongst school children. A constant medical inspection of the school and of the pupils should be instituted, but these should in no wise interfere with or render unnecessary the sanitary inspections previously recommended.

Periodical tests of the vision of school children should be made by the medical officers, and from time to time the printed text-books furnished to the scholars should be examined with a view of the effect of the type upon the vision. While school teachers should take an interest in all these matters they should above all watch the sanitary condition of the building. The promiscuous use of books and pencils is fraught with danger; books and pencils distributed in a class should always go to the the same children, as both may be the means of infection from one child to another.

In the large school-houses there should be a special room set apart as a lunch room, for pupils who remain in case of bad weather if they live too far from the school. During the airing and ventilating of the class-rooms the pupils may also use such a room. Lunch-rooms are particularly desirable where the noon recess is so short that pupils cannot go home. It is to be recommended that the lunch-room be provided with simple gas stoves, for the warming of the children's lunches.

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SANITATION OF MARKETS AND ABATTOIRS

V

SANITATION OF MARKETS AND ABATTOIRS

In the following, I propose to discuss briefly the buildings devoted to the provision of healthful food supplies for the large cities, in particular their interior planning and construction, their mechanical equipment and the sanitary arrangements required for them. Prominent among such buildings are the *city markets* and the *abattoirs*. Both kinds of structures require the solution of interesting and often intricate architectural, engineering, sanitary and economical problems.

1. **Markets.**—In general the term "market" is applied to public places or squares in cities and towns, where meetings are held or where crowds congregate for the purpose of buying and selling articles of food supply. In a restricted sense, it is used to designate the buildings intended for the sale and purchase, at certain hours daily, of food products. The city markets, as we shall see later on, are usually built by the municipality.

2. **Abattoirs.**—The abattoirs or public slaughter-houses are buildings and places intended for the slaughter of domestic animals, and for the dressing, packing, and shipping of the meat. In some cases these buildings are municipal buildings, particularly so in Europe, but in the United States they are largely built by private enterprise.

MARKETS.

3. Food Supplies.—The food supplies of a city comprise:

(*a*) vegetables, salads, fruit, and other products of the soil and plant life.

(*b*) animal food, such as meat, game, poultry, fish, eggs, milk, butter, and cheese.

All food kept exposed for sale in the markets should be pure, fresh, and wholesome, and its sale should not cause or create unsanitary conditions. Some food rots quickly if exposed to rain or snow; other food is very sensitive to heat or cold. Decayed fruit, rotten vegetables, spoiled or tainted meat should be at once condemned and removed. The larger the city, the more complex, difficult, and troublesome become these problems of food supply and food control.

4. Development of the Market Building.—Markets for the sale of provisions were known to some of the nations of ancient history. The Greeks, for instance, made use of open market squares, called "agoras," which they often surrounded with two-story arcades. The Romans had oblong markets, called "forums," with wide porticos. The market squares were sometimes richly adorned with the statues of famous citizens, with sculptural monuments and with fountains. Later on markets began to be roofed over, but were kept freely open on the sides, as for instance in Italy.

During the Middle Ages, public fairs were periodically held in the open squares or market places of many cities, some fairs being devoted to only one class of goods, others offering to the buyers facilities for the purchase or exchange of many different kinds of merchandise or commodities. They were generally combined with church or guild festivals or kermisses, at which a large gathering of people, who often came from long distances, took place. Later on, retail stores were opened in cities on business streets and on main thoroughfares, and these somewhat relieved the crowded condition of the city markets. At the beginning of the present century market buildings became confined to the sale of food supplies and provisions; in deference to practical considerations they were gradually replaced by covered structures.

In Paris, the Emperor Napoleon I. was the first to establish such public markets. The erection of the famous "Halles Centrales" was commenced under his reign in the year 1811, but they were not entirely completed until 1878. They embraced ten large buildings, covering a total area of 44,000 square metres or about 11 acres; their total cost was about ten million dollars, the annual running expenses two hundred thousand dollars, while the yearly revenue to the city amounted, a few years ago, to from 1½ to 2¼ million dollars.

London, Berlin, and other large capitals of Europe followed very soon in the erection of imposing and permanent structures similar to those of Paris. At the end of the nineteenth century Berlin had 15 large markets, where all food was controlled by sanitary inspectors, and where all meat sold at retail was examined and marked. London had four large markets and Vienna had eight such buildings. In the United States, many cities have public market buildings. As examples might be mentioned the Fulton, the Gansevoort, and the Washington markets in New York City; the Wallabout market in Brooklyn; the Faneuil Hall market in Boston and others. None of these, however, can be compared in size or magnitude of the structural work with the grand structures to be found in some of the cities of Europe. It is related that there was a public market in the city of Boston as early as the year 1634, and a hundred years later we find the city had three markets. In 1834 the city of Boston built the large Faneuil Hall market, which cost upward of $150,000 and contained 160 stalls to be rented. This building is at present in charge of one superintendent under whom 1400 men work.

5. Advantages of Public or Municipal Markets.—Market buildings are utilitarian and sanitary structures, intended for the convenient exposing, selling, and buying of food.

The chief advantages of covered markets are: The buyers and sellers, the market people and the public are protected against the inclemencies of the weather, while the provisions are not so liable to be damaged or entirely spoiled by rain, snow, heat, cold, or by the street dust, by dirt and smoke, and they can be better exhibited and exposed for inspection and for sale. The buyers are offered a greater choice of food supplies, they can obtain fresh food products daily, the buying and selling is rendered more convenient and the prices of provisions become better regulated, more uniform, and in a great many cases cheaper, owing to the reduction in the rent and of the running expenses.

City markets also facilitate the thorough supervision, and render more efficient the inspection, of the food supply by the sanitary police, whose chief duty is to prevent the sale of diseased or decayed meat or other food. Under official supervision, the waste materials are promptly removed, and are therefore not so liable to become a nuisance to sight and smell, or a danger to public health in populous localities. Covered market buildings also afford improved facilities for the storage of those food products which remain unsold at the close of the day.

The soiling of streets and squares uanvoidable where these are used as open markets, is done away with entirely, and the street traffic and the safety of pedestrians are better maintained. Moreover, public market buildings constitute, if properly managed, a source of considerable revenue to the city.

6. Location.—The location of city market buildings depends to some extent upon their character. Large cities in Europe have not only wholesale but also retail markets. The former are always located conveniently near to the traffic and shipping facilities, to the railroads, to river or canal transportation, to the harbor wharves and docks, or to the main roads or highways leading from the surrounding country districts into the city. Retail markets, on the other hand, are located in or near the centres of the most populated city districts, so as to be conveniently and quickly reached by the public and the small trades people. In populous cities, therefore, a large number of well-appointed market buildings are desirable.

In the United States, many of the market buildings are devoted not only to the wholesale, but also to the retail trade; the large buyers, such as the chefs or stewards of hotels, restaurants, institutions, steamship lines, the intermediate purchasers or jobbers for the grocery establishments, the provision stores, and the smaller private markets buy their stock of provisions in the early morning hours; later on, the retail purchasers come to the market, among them the housekeepers, boarding-house keepers, and many house-wives, who prefer to make personal selections at the market, and who are anxious to obtain their supplies in a thoroughly fresh condition.

Markets for cattle, to be sold for slaughtering, are generally located close to, or in connection with, the slaughtering establishments, and are usually termed "stock yards." Other special markets, such as fish and oyster markets, are located convenient to the harbor or the docks; markets for the sale of flowers are sometimes held in the early morning hours on the city squares, as for example the flower market in Union Square in New York City.

7. Constructive Features of Market Buildings.—Market buildings should be inexpensively designed, but should be built in a substantial manner, and so as to be thoroughly sanitary. They are constructed either of brick and stone, or of iron and glass; wooden structures should not be tolerated. Where it can be avoided, such buildings should not be placed in a closely built city block; buildings placed on open squares and standing entirely detached are much preferable. Provision should be made so that all kinds of vehicles and trucks have easy access to the market.

The chief constructional requirements are the following:

(1) the halls must have ample light;

(2) they must not be draughty, yet be well ventilated;

(3) they must afford plenty of floor space and storage-room;

(4) they must have plenty of exits and passage ways, also driveways for the loading and unloading of wagons.

(5) they must be well and substantially constructed.

Ample floor space is an essential requirement, and hence market structures generally cover a large area of ground. Suitable provision must be made for a number of wide entrances and exits to facilitate the market traffic. Wholesale market buildings require suitable arrangements for loading and unloading the trucks, which carry the provisions, and the wagons of market gardeners from the rural suburbs; also driveways for the carts and wagons of the buyers, and rail connections with the available freight lines for the prompt receipt of provisions coming from long distances. All driveways require to be well paved and drained.

8. Interior Features.—The interior of a market building is usually a one-story lofty hall structure, covered either by wide-span roof trusses, or having smaller roof divisions, supported by intermediate iron columns. The columns are not objectionable as they can be utilized in the division of the sales-stands.

The whole interior is sub-divided by several longitudinal main aisles, each being from ten to fifteen feet in width, with numerous passage-ways or cross aisles at right angles to them, the cross aisles being made from five to seven feet wide.

Woodwork should be avoided in market hall interiors for well-known reasons. The walls should be of iron or steel and glass, or else of brick. Perfect cleanliness being an essential requirement, the walls should be finished with a non-absorbent material to a height of at least six or seven feet. For this purpose, the walls may be faced with glazed bricks, or they may be lined with white tiles, or else they are simply plastered with hard plaster or cement, which is often painted with light-color enamel paint.

The construction of the floor is of much importance. It may be of cement, of asphalt, or of hard-burnt paving brick. It may also be laid with large square slabs of marble, or be tiled, a rough tile being preferable because it does not become slippery.

The buildings generally have cellars with cool vaults for the storage of such provisions as are left unsold. The cellars may be arched over, and the floor made waterproof, and finished either in asphalt or in cement, or with asphalt paving-blocks, or hard-burnt paving bricks; sometimes a marble mosaic floor is used. Hydraulic or electric lifts should be provided to take the food supplies down to the cellar.

9. Interior Equipment.—The interior equipment is generally quite simple; the spaces formed by the aisles and cross-aisles are sub-divided into open, or sometimes closed or housed-in, sale stalls. These are usually raised one step above the floor level of the hall. The stalls are fitted up with tables and chairs, with benches and chopping blocks, with racks, shelves, and iron stands, fitted with numerous large hooks. The usual sub-division is into stands for meat and poultry, for vegetables, for fruit, for dairy products, such as eggs and butter; for fish, oysters, lobsters, and other sea food. The meat and fish stalls require a more careful fitting up with marble, slate, or soapstone table boards. Large fish markets are provided with basins filled with either fresh or salt water for the keeping of live fish and lobsters; occasionally some stalls are reserved for keeping live fowls for sale.

Where there are cellars for the storage of goods, there should be also convenient stairs for access, in addition to the lifts already mentioned.

The upper floors or the galleries are utilized for offices for the food inspectors and officials of the sanitary police, also for the superintendent in charge of the market building, for his assistants, and for the market cleaners and employees. Sometimes a dining-room or restaurant is provided.

10. **Refrigerating Plant.**—Modern market buildings are almost always provided and equipped with a refrigerating and cold-storage plant, and in addition to numerous large refrigerators there are included artificially cooled rooms for the storage of meat, poultry, eggs, and other products which become easily affected by the heat.

Where refrigerators and cold-storage chambers for ice are used, the waste-pipes for the melting ice must be properly and safely disconnected from the soil-pipes and the sewer. It must be borne in mind that meats, fish, and other articles of food are quickly spoiled when exposed to sewer emanations.

11. Maintenance of Cleanliness, Water-supply and Plumbing.—The maintenance of cleanliness in market buildings is of paramount importance, hence particular attention should be paid to the sanitary equipment. Good sanitary conditions require the provision of a plentiful supply of water, and suitable and ample arrangements for the flushing of the floors and the washing of walls. In the floors there must be plenty of well-trapped drainage openings, which in turn must be sewer-connected. For the washing of the floors and the flushing out of the floor cesspools numerous hydrants or sill-cocks with connections for rubber hose must be installed. Separate well-kept and sanitarily arranged toilet-rooms for both sexes are needed.

12. Ventilation.—Market halls should be well ventilated. Ventilation is generally accomplished by means of high side windows, fitted so as to swing on a horizontal axis, or else by raised ridge roofs with louvre windows. Good ventilation is of paramount importance in market buildings, not only because of the large crowd of persons who visit the market daily, but also on account of the necessity of removing the strong odors due to some of the supplies, like fish, cheese, meat, etc., and finally because it is necessary to maintain the food supplies in a good condition. At the same time it is important that the lower part of the market hall should be free from annoying and objectionable draughts. Provision must be made to heat the building in winter time.

13. Lighting.—Ample daylight illumination is essential, supplemented by gas or electric light for the dark winter mornings. Plenty of light is also a safeguard against the possible sale of food which has begun to decay; it is likewise necessary for the maintenance of cleanliness.

14. Removal of Waste Food and of Offal.—Floors and passageways of market halls, as well as the surrounding streets, should be kept scrupulously clean. To accomplish this, constant vigilance and care must be exercised by the officials in charge of the building. Decomposing vegetable or animal food should not be permitted to accumulate, and in order to maintain healthful conditions, a daily or more frequent removal is imperative. During the hot weather, frequent flushing with water and the occasional application of approved disinfecting liquids should be practised.

All pavements and floors should be non-absorbent and should be well drained to prevent the formation of stagnant pools of filthy water. Galvanized iron covered receptacles should be used for the collection and removal of waste bits of food, butcher's offal, etc. Water-tight covered carts should be provided for the removal of waste matters; open carts should not be tolerated.

The removal of condemned food and of all waste and offal should be regular, prompt, and efficient; a daily removal is absolutely necessary. Pending transportation, all waste should be stored in tight, well-covered, and well-kept galvanized iron receptacles. Strict regulations and rules for the sanitary maintenance of market halls should be issued by the municipal board of health, and a daily inspection is required for the enforcement of the rules. In addition to the daily sweeping of the market halls, attention should be paid to the passageways and to the streets adjoining a market.

ABATTOIRS.

15. **Object of Abattoirs.**—Let us now turn our attention to the public abattoirs, or organized slaughter-houses of cities. The modern general tendency towards centralization, which we find in so many large and successful industries, has in recent years been applied to the places, or buildings, where animals are slaughtered. The prime object of public slaughterhouses is to do away with the nuisance, which was in former times so common, of doing the slaughtering in private yards or butcher shops, scattered throughout the various districts of a city. In the large cities in particular it was found to be almost impossible to exercise a proper control of the private slaughtering establishments. The effort toward centralization or concentration of this important industry came about principally through the desire, from the public health point of view, to secure a more careful and strict control of the live animals as well as of their meat.

16. **Evils of Private Slaughter-houses.**—It became obvious, long ago, that it was uneconomical, unsanitary, and impracticable to slaughter live stock at the butcher shops or the selling places for meat. Many evils were connected with this pernicious practice, such as:

(*a*) the annoyance and sometimes the danger arising to pedestrians from the cattle being driven through the city streets;

(*b*) the lack of adequate slaughtering facilities;

(*c*) the difficulty of a proper official meat inspection, because an unreasonably large force of inspectors was required;

(*d*) the danger to the health of the population arising from the possible sale of diseased meat;

(*e*) the universal, unsanitary, and often offensive conditions of the slaughtering places, caused by the deficient facilities for cleanliness;

(*f*) the improper disposal of the animal waste matters, which resulted in nuisances, bad odors, and in soil, air, and water pollution;

(*g*) the annoyance to the public, incident to the removal of the offal and waste through the streets;

(*h*) the nuisances arising from the keeping of animals before killing, as well as the noise incident to the killing process;

(*i*) the bad effects of exposing the slaughtering processes to the eyes of children;

(*j*) the lack of regulation in the methods employed and the failure to adopt improved methods of killing the cattle;

(*k*) and finally the increased cost of the meat supply to the consumers.

All the objections cited are removed and overcome by the only proper remedy, which consists in the concentration of the business of killing animals, intended for food, and the erection of central abattoirs or public slaughter-houses, removed from the crowded city districts to the city limits, and simultaneously with this the abolition of all small private slaughtering places, located in the heart of the city.

In order to render public abattoirs successful it is absolutely necessary that the municipality should have the legal right to prohibit private slaughtering, to establish laws making the slaughtering at the public abattoirs obligatory, and to make rules and regulations insuring the killing of cattle and hogs and the preparation of animal food products under conditions favorable to the public health.

17. **Advantages of Central Abattoirs.**—Numerous advantages arise to a city from the establishment of central public abattoirs, and chief amongst these are the following:

(1) They do away with all the injurious features, previously mentioned, connected with private slaughter-houses, when these are scattered among the populous city districts. The public health is considerably improved by the abolishment of the ill-kept private slaughtering establishments, which are generally reeking with filth, and hence become offensive to the entire neighborhood. The public health is protected, because the slaughtering business is carried on in the public abattoirs on sanitary principles, and because cleanliness is maintained, and good order and business system prevail.

(2) Offensive odors and disagreeable noises connected with the slaughtering business are either removed entirely, or reduced to a minimum. Unsanitary condi-

tions, resulting in the pollution of the soil, the air, and of surface- and underground-waters are removed.

(3) The street traffic is benefited, because the driving of cattle through the city streets is either done away with entirely or considerably reduced. This in turn facilitates the maintenance of the streets in a clean condition.

(4) The sanitary inspection of the animals before slaughtering and of the meat after killing is greatly facilitated and performed in a more organized and careful manner. The sale of unwholesome or diseased meat is more efficiently prevented.

(5) The butchers are offered better facilities for the killing of the animals and for the dressing of the meat; the killing is done in a humane way and under the constant superintendence of qualified inspectors. Owing to increased facilities for the storage and keeping of meat, the latter does not so readily spoil. Moreover, better facilities exist for the maintenance of cleanliness.

(6) Central abattoirs also facilitate the disposal, prompt removal, or commercial utilization, of the numerous waste products of slaughtering. The hides, blood, the fat, the bones, the entrails, and the offal are taken care of in properly-arranged establishments, which form adjuncts to the slaughter-houses.

(7) In case of cattle epidemics, there is a better control of the animals to be butchered.

(8) In large abattoirs slaughtering is done more economically, hence the prices of meat are better regulated and kept lower. The entire business is accomplished in a more orderly and systematical manner, a

steadier supply of meat is furnished and a scarcity in the meat supply cannot so easily occur.

18. Private and Municipal Abattoirs.—Large public abattoirs may be built and erected, first: by the municipality; second: by butchers' associations or corporations; third:by private individuals or firms.

In Europe, municipal abattoirs are the rule, and we find there only a few instances of abattoirs erected by private individuals. In the United States the majority of abattoirs are built by butchers' associations (for example those of New York City and those at Brighton, near Boston), while others are established through the enterprise of private firms.

It seems, generally, preferable to have public abattoirs built and controlled by the municipality, for the slaughtering of animals for food and the inspection of the meat involve sanitary problems which should be under the control of the sanitary police. In some instances, the meat inspection and control is performed by the State Board of Health, and in some very large abattoirs, from which meat is exported to foreign countries, as in Chicago, there is a Government inspection.

There is no doubt but that large central public abattoirs, erected by the city, offer the best solution of the problem of the sanitary control of the meat supply. Cleanliness and sanitation can be enforced efficiently only where these buildings are owned by the city. When this is the case, the city rents the slaughter-stands or compartments to the butchers, and in this way the abattoirs become a source of considerable municipal revenue.

19. Development of the Abattoir.—It is interesting to review briefly the historical development of the public abattoir. Ancient Rome had such public slaughter-houses and a guild of butchers existed during the reign of the Emperors, whose members were privileged to kill animals intended for meat supply. The slaughtering was done in special buildings. With this single exception there did not exist in any country previous to the beginning of the nineteenth century any organized system for the slaughter of cattle. The butchers usually slaughtered the animals on their own premises, hence the official meat inspection was very difficult and often proved quite insufficient. The annoying odors from the scattered slaughter-houses constituted an enormous sanitary evil.

The public abattoirs may be said to have originated at the beginning of the nineteenth century in France. The Emperor Napoleon I., to whose active interest, as I have already mentioned, we owe the establishment of the first public market buildings in Paris, gave the matter considerable attention. Recognizing the many sanitary, commercial and economical advantages due to centralized public abattoirs, he authorized and ordered their construction in the suburbs of Paris in the year 1807. He issued at the same time a decree, forbidding entirely all private slaughtering in the small shops. Three years later, in 1810, he caused laws to be passed applying to the entire country. In 1815 five public slaughter-houses were opened, covering 38 acres of ground, which were considered models of construction and internal equipment.

Since then, many large cities of other European countries, and even smaller towns, have followed the example of Paris and erected public abattoirs. Even the use of the French word "abattoir" has gone over into the English and German languages. In Prussia, a law was passed in 1868 prohibiting the slaughtering of cattle anywhere except at the public abattoirs. In order to show the rapid increase in the number of such public buildings, it may be mentioned that in 1870 Germany had about 80 abattoirs, in 1896 over 600, and in 1902, 836 public abattoirs, of which 71 had also large stock yards connected with them. In no other country has so much been accomplished in the matter of municipal abattoirs in recent years as in Germany, and some of the large German establishments, which the author has recently visited and inspected, are models of construction and equipment, and have in some instances been followed elsewhere. In my judgment, American cities could profit greatly by studying the best examples existing in the older civilized countries. In the United States many private abattoirs and packing houses of great size exist, particularly in the large Western cities, which are also the centres of the cattle market, such as Chicago, Kansas City, St. Louis, Cincinnati, and Louisville. The largest central live stock depot and the largest abattoir in the United States is at the Union Stock Yards at Chicago.

In New York City, slaughtering-houses prior to the year 1866 were scattered over all parts of the city, to the great detriment of the health of its inhabitants, but in more recent years several central abattoirs have been erected by private enterprise, and the most recent example will be again referred to further on as a model of construction. In Boston, large abattoirs were built at Brighton under the supervision of the State Board of Health. Some of the public abattoirs of American cities are immense establishments, fitted up with the most elaborate and latest improved machinery for the rapid performance of the work and for the humane killing of a very large number of animals; they also have well-arranged auxiliary buildings intended for the sanitary and commercial disposal of the offal incident to slaughtering.

20. Unsanitary Conditions of Abattoirs.—Not all of the existing abattoirs, however, are models of construction from a sanitary point of view, in fact in many of these buildings unsanitary conditions exist, forming a menace to the public health. Not a few of the structures are of wood and dilapidated, the ground beneath the buildings is soaked with blood and putrefying filth, accumulated during many years. Many buildings lack proper sewerage facilities, the floors are soaked, slimy, and slippery and are not properly washed or flushed, the walls are spattered with blood, grease, and hair, or covered with mould.

Even the processes of slaughtering and dressing the animals are carried on in an uncleanly and unsanitary manner; the workrooms are poorly lighted and unventilated, the windows obscured with dirt, inside rooms without light or air are crowded with workmen and working girls, who are compelled to breathe the air, rendered unhealthy by exhalations from rotten wood and decaying meat scraps or putrefying grease. The work-tables, benches, the meat racks, and the receptacles are inadequately cleaned. No attention is paid to the provision of proper and decent toilet-rooms and lavatories for both sexes; the inadequate provisions made are sometimes found located in corners of the very workrooms. There is a general lack of consideration for the health and the comfort of the employees. Conditions, such as I have briefly mentioned, would even appear to be the rule rather than the exception in some establishments.

Reference was made to some of these deficiencies and faults in an article by Dr. Stiles on "The Country Slaughter-house as a Factor in the Spread of Disease," published in the Year Book of the Department of Agriculture for 1896. More recently, public attention has been drawn to this indescribable state of affairs, not only by the descriptions contained in Upton Sinclair's work "The Jungle," but also by the report of the investigation, made at the request of the President of the United States, by Dr. Chas. P. Neill, Commissioner of Labor, and by James P. Reynolds, Esq., Sociologist. It is perhaps to be regretted that the Commission, entrusted with the work of investigation, did not include a sanitary expert, but it is reasonably certain that if laymen could find and enumerate so many defects as are mentioned in the report referred to, still graver sanitary defects would probably have been discovered by a more thorough technical investigation.

The immediate effect of the publication of the report mentioned has been that numerous improvements in the sanitary arrangement and equipment of many abattoirs were carried out, also that stringent rules and regulations were passed by the United States Department of Agriculture for the proper meat inspection and for the sanitation of the buildings.*

It should be mentioned that the large abattoirs of Western cities have always attached to them immense packing houses, in which the preparation of meat food products, sausages, canned meats, etc., takes place. It is quite obvious that an official sanitary inspection of such incidental trades, which form a very important modern industry, is quite as much required as that of buildings where only slaughtering is done. The considerations given in the following pages, however, refer only to the latter class of buildings.

21. **Site for Abattoirs.**—The site for a public abattoir should be chosen in the outskirts of a city; it should be isolated, yet easily accessible from all sides. There are a few good examples of abattoirs located within built-up city districts, but as a rule an outside location is preferable, as it does away with the noises and smells inevitable where many animals are kept together in readiness to be slaughtered. In no case should abattoirs be placed in close proximity to the residential districts.

In selecting a site, the three important questions of water supply, drainage, and of convenient traffic connections must be duly considered. Where the town is located on a river, it is preferable to put the abattoir

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* See Appendix D.

below the town. The site should offer facilities for the transportation of the cattle, good connections by rail, by water, and by the country highways in localities where the adjoining rural districts are devoted to cattle raising.

A large area of suitable ground is required, because a public abattoir is really a conglomeration of many buildings. Sufficient acreage should be acquired or set aside to permit future extension and growth. In nearly all cases the markets for cattle to be sold for slaughtering, sometimes designated as "stock yards," are placed adjacent to and in immediate connection with large abattoirs. By thus combining the live-stock market with the slaughter-house the sanitary inspection of the meat supply of the city is rendered more concentrated and proportionately more efficient and simple.

The site for cattle yards should be elevated and dry. A liberal area of space is required for the cattle-pens, the sheds, and other adjuncts. The sheds are usually grouped around paved yards, and the drainage of the roadways between the sheds and of the yards, also of the sheds themselves, requires the closest attention. There should be convenient connections with the railroads and wide platforms for the unloading of the animals from the freight cars. In connection with large stock yards there should always be a well-appointed disinfecting station for the cattle cars.

22. Buildings Composing an Abattoir.—Large public abattoirs are composed of a number of buildings. First of all there must be large sheds, pens, and stables for the animals which arrive; these buildings are sometimes sub-divided into separate sheds for cattle, calves, sheep, and for pigs. They, however, present no special features worth mentioning. Next we have the buildings where the animals are killed, and in large establishments there are usually separate slaughter-houses for each of the groups of animals named. There must also be special buildings for the dressing of the carcasses, for the cleaning of the meat, and the entrails, also buildings for the cold storage of dressed meat, and other special buildings must be provided for diseased or suspected animals.

Then again, we have buildings devoted to the commercial utilization of the offal, such as fat rendering and bone boiling, and cremators or destructors for the condemned meat. An administration building should be provided, containing the general offices, the rooms for the sanitary inspectors, for the veterinary surgeons and laboratories for the microscopical examination of the pork. There is usually provided a separate boiler and engine-house, containing the power plant, viz., the pumps for water supply, the dynamos for lighting, and a complete refrigerating and ice-making plant. In rare cases a regular wholesale meat market forms a part of the abattoir. In European cities, the bureau for the official inspection and control of the meat supply is considered of the highest importance and a good deal of space is devoted to the same.

All the buildings named must be equipped with the latest and best labor-saving devices, with all modern sanitary conveniences, and with impervious and properly-drained floors, while a liberal water supply and other equipment facilitate the maintenance of cleanliness.

The value of the by-products of the slaughtering processes is nowadays recognized to be quite high; usually a considerable economy in the management of an abattoir may be effected by a proper utilization of the same. The buildings in which the by-products, such as blood, hides, tallow, bones, intestines, and hair, are treated, should be situated conveniently near and form adjuncts of the slaughter-houses proper. It is necessary that all these buildings be kept under proper sanitary supervision. The noxious vapors and gases, arising from the cans and kettles of rendering establishments, must be made to pass through condensing-tanks and then under the fires of the boilers, and be finally discharged through the tall chimney stack of the boiler-house.

23. Planning of Abattoirs.—The correct grouping and location of the several buildings is important and depends somewhat upon the size and shape of the lot; it is also dependent upon the provisions available for good shipping connections. No general rules for the planning of abattoirs can be given, as each special case forms a problem in itself. In general, three types may be distinguished.

In the first of these, the buildings are all concentrated, roofed over, and interconnected by covered passages. This type requires a smaller floor area and causes a reduction in the cost of construction; its compactness favors easy management and superintendence, but the drawbacks are that the building as a whole can only be enlarged with difficulty, and that there is often an insufficient supply of light and air. In the second type the different buildings are separated by open courts, streets or alleys, and each building may be readily enlarged if necessary, and light and air are provided in abundance. In the third type, which may be called a combination of the other two, the buildings are separated from each other, but interconnected by covered passages and courts, and this is probably in many cases the best system.

The majority of abattoirs are buildings of only one story, the killing house being located on the ground level, while the by-products of slaughtering are stored in the cellar. There are, however, a few modern examples of buildings of many stories, and in these it is customary to take the cattle to be slaughtered to the highest floors, and then to locate the different processes and operations of dressing the carcasses, of cleaning the hides and of treating the offal on the lower floors. An example of this type of abattoir may be found in the new model slaughter-house, built in New York City for the Butchers' Association, and located on 11th Avenue and 39th Street, a description of which is given in Appendix C.

24. The Main Slaughtering Hall.—Among the buildings forming a public abattoir, the one in which the slaughtering or killing of the animals and the dressing and chopping of the carcasses are done, is of prime importance. The arrangement of the structural features of the killing house or hall require therefore special mention.

We may distinguish two different types. In the first type, which is the one most universally met with in German abattoirs, there is one large open and undivided slaughtering hall, in which all the different butchers work together, whereas in the second type there are provided two rows of smaller killing compartments, arranged one on each side of the central aisle, each compartment being rented out to one or to several butchers. This type of killing hall is the usual one in France, in Belgium, and in Italy. The first described type is, however, very much preferable from a sanitary point of view, because it facilitates the official supervision of the slaughter trade, and necessarily, to some extent, involves a mutual inspection by the butchers of their work. The first type is also cheaper in construction, for it does away with the many dividing walls of the compartments. For the different kinds of animals there are usually provided separate and distinct slaughtering halls, hogs in particular are nearly always killed in special buildings.

25. Features of Construction.—Regarding construction, it may be stated that the outer walls of slaughter-houses may be built of either brick or stone, or else of iron with glass sides and roofs. Wooden buildings should never be put up.

In the construction of the interior, it should be borne in mind that there is a great deal of constant wear and tear in such buildings, and hence that the first requirement is the durability and strength of the building materials employed. Woodwork should be used as little as possible. On account of the slaughtering processes carried on in the buildings, it is quite essential that the inside walls to a height of six or seven feet from the floor should be rendered impervious, smooth, and easily washable, so that dried blood and scraps of flesh adhering to them can be readily removed by means of warm water and soap. The walls may be faced with light-colored glazed brick, or else they may be tiled with white glazed tiles. In cheaper constructions, the brick walls are coated with asphalt varnish, and any wooden posts or partitions should be treated in a similar manner. Whatever the wall surface be, it should be smooth and such as to be easily washed and cleaned.

26. **Floors.**—The floors of a slaughter-house should be solid, non-absorbent, and impervious to moisture of any kind; moreover, they should be hard and durable, but they should not crack, nor should they be too smooth or slippery, as this would interfere with the operations of the butchers. It is somewhat difficult to reconcile these conflicting requirements. Asphalted and concreted floors have been much recommended, but on trial they have in some buildings proved to be only partly successful. Asphalt floors are apt to become soft in summer time; the cement floors, on the other hand, may crack or they become chipped or broken by the axes of the butchers and require constant repairs. In some cases roughened bluestone slabs have been used with success; another good pavement is formed of two layers of hard-burned brick, laid on edge in cement or in concrete, but this is necessarily expensive. Many butchers maintain their preference for a wooden floor, probably on account of its non-slipperiness, and notwithstanding its lack of durability and the fact that it absorbs organic impurities. Heavy planks of Georgia pine calked thoroughly water-tight at the joints in the manner of a ship's deck are satisfactory, but since the planks become

rapidly splintered by the blows of the axe used in slaughtering and in dividing up the killed animals, it becomes necessary to put down a second layer of planks, in other words, a double flooring, and to keep the same always in thorough repair.

The floor should always be well graded and sloped to floor drains; sometimes special floor troughs or gutters are provided, and arranged so as to catch the blood and to carry the same to special receptacles. The upper parts of the walls and the ceiling should be plastered or whitewashed at frequent intervals. The roof may be pitched and covered with slate, or made flat and finished with metal or tar and gravel.

Sanitary Features.

27. Water Supply.—In centralized slaughter-houses enormous quantities of water are used during the day, hence one of the chief requirements is an abundant and very liberal supply of both hot and cold water. In Europe, where water is ordinarily not used as liberally or wastefully as in the United States, the supply required is estimated at seventy-five gallons per each animal per day. While this figure includes the allowance for the watering and washing of the cattle, and for the washing of floors and the sprinkling of the roadways, it does not include the volume of water required for the condensers of the refrigerating plant. This latter is estimated separately at 150 gallons for each head of cattle slaughtered.

The water supply may be obtained from the mains of the city water-works, or else it may come from a separate local plant. Where the abattoir is located at some distance beyond the city limits, it often becomes necessary to provide a separate water-supply system, requiring one or several wells, a set of steam pumps, and one or several high-service water-tanks or else pressure-tanks.

A complete system of water mains should be installed covering all buildings of the abattoir, so that water may be drawn at any place where it may be required for washing, flushing, or other use. Provision should likewise be made for a good supply for fire protection purposes, including the setting of plenty of fire hydrants. As the buildings are not very high, and as most of the water is drawn at taps located on the ground-floor level, the water-tank for abattoir use need not be raised very high, but to obtain sufficient pressure at the hydrants for fire extinguishing purposes, it is best to arrange for a separate elevated water-tank for fire purposes, or else to use a large pressure-tank located in or near the power-house.

Sometimes the water distribution is so arranged that the city supply, where available, is used for fire purposes, while the local supply covers all other water requirements.

In the buildings, the main-supply pipes should be ample in size and should be carried either at the cellar ceiling, or else high up on the first floor, where the pipes are not so liable to be damaged. Numerous inside taps are required, not only at the troughs and other plumbing fixtures, but also for hose use.

Hot water is likewise required in large quantities, particularly at the places where the cleaning of the intestines is done; also for the baths and lavatories for the employees. It is best to arrange this, by providing in the power-house a large hot-water tank, or a feed-water heater heated by exhaust and by high-pressure steam.

28. Drainage.—For all abattoirs good drainage is very essential. In the main slaughtering hall, numerous vitreous ware or solid porcelain ware troughs should be provided for the use of the butchers, each of these having a trapped waste-pipe and connection with the main sewer of the building. The floors of the hall should have trapped floor drains at suitable points, and sometimes open gutters are provided, besides special troughs for the removal of the blood from the slaughtered animals.

The general rules on sewerage and plumbing, which have been formulated for other classes of buildings, are also applicable to slaughter-houses, hence it seems superfluous to go into their details.

Where the abattoir is composed of many buildings, a general sewer plan should be laid out. In many cases it will be found advantageous to provide two sewer systems, namely one for storm-water from the paved yards and roadways and for the roof drainage, and a second separate system for the waste water from the buildings, including the toilet and bath-rooms.

The main sewers are usually pipe sewers, constructed of vitrified or glazed sewer-pipes, or where they are larger and egg-shaped, built in concrete. The sewer-pipes within the buildings should be of heavy iron pipe, and care should be exercised to give them a sufficient *fall, to* prevent deposits and stoppages. All catch-basins, troughs, and sinks should have efficient strainers, and flushing arrangements should be provided.

Manholes should be placed at junctions and at changes in grade and alignment. The bottoms of the manholes should be built on a level with the flow line of the sewer and there should be no depressions or sumps in the bottom, which would collect and retain deposits of organic putrefying matters. All sewers should be ventilated in the most practical and efficient manner.

29. Purification of the Waste-water.—Although the waste-water from abattoirs is not nearly as highly polluted as that from some manufacturing establishments, yet it is necessary that it should be purified before being discharged into a water course. In Europe, one finds at many abattoirs local purification plants for the sewage. In all such instances it is, of course, advisable to exclude the roof and yard drainage from the "sanitary" sewers.

The means used for purification are either mechanical, chemical, or biological, and sometimes a combination of two methods is employed. Very often, the plants comprise large settling-chambers or regular septic tanks, in connection with one or more tanks for chemical precipitation. Coke and gravel filters are also much used. The favorite method seems to be at present the chemical precipitation, but more recently biological sewage disposal methods have also been installed.

30. Lighting.—Good daylight illumination may be attained by providing the building with plenty of large windows; this is essential both for the maintenance of cleanliness and for the careful inspection of the meat.

Artificial illumination is secured by means of either gas or electric light. If the gas mains of the gas works extend to a point near the abattoir, gas lighting may be used; a separate gas lighting plant is not recommended except possibly an acetylene lighting plant. Steam being available in the power-house, it is easy to arrange for an individual electric light plant.

31. **Toilet- and Bath-rooms.**—There should always be provided the necessary number of well-kept and well-ventilated toilet-rooms, arranged entirely separate for both sexes. Modern abattoirs are also frequently provided with shower- or rain-baths, for the use of the butchers' help. These should be placed in the vicinity of the large killing hall. The details of the plumbing fixtures suitable for use in abattoirs do not differ from those in universal use in other manufacturing establishments.

32. **Heating and Ventilation.**—Artificial warming in not usually required for the large killing rooms, but the offices, toilet-, and bath-rooms, the microscopical laboratories, and the restaurants should be suitably warmed in winter. Low-pressure steam-heating is therefore usually installed. High-pressure steam is required for disinfecting purposes.

The pens and stables for the cattle, the large killing hall, or the several killing compartments, and the places where the meat food products are prepared, require abundant ventilation.

33. **Maintenance of Cleanliness.**—A good water supply and proper drainage facilities will be a great help towards maintaining the entire establishment in a decent and *cleanly condition*. In addition, there should be the

very best arrangements for the prompt removal of all waste accumulations which attract both rats and flies; both pests must be kept out of a slaughter-house at all hazards. All offal, animal manure, fat, etc., should be removed quickly and regularly.

The maintenance of absolute cleanliness in every part of the buildings is of the greatest importance. Nuisances arise, not only from the accumulation of filth on or about the premises, but likewise from imperfect or improper modes of disposing of the slaughter-house refuse. A prompt disposal of the manure from the cattle yards, the pens, and stables, is indispensable and should be carried out with regularity. All streets and alleys throughout the abattoir should be swept daily and washed frequently. The places or buildings in which diseased animals are kept, require special disinfection.

Not only the buildings, but also their equipment must be constantly kept in a sanitary condition, in order that all work of slaughtering and preparing the meat or the meat-food products be performed in a cleanly and sanitary manner. Ceilings, walls, and columns should be frequently washed, scraped, and whitewashed or painted. All floors should be kept washed and flushed. The trucks, trays, hoists, tables, racks, platforms, and receptacles of all kinds must be kept scrupulously neat. Knives, saws, utensils, and butchers' tools or implements of all kinds should be cleansed daily and frequently sterilized. The same precautions are required as regards the working clothing, such as aprons, etc., of the employees. These must be required to wash their hands before handling any meat, and to disinfect them when diseased carcasses are handled. The manager or the superintendent should see that these rules are enforced. The meat inspectors should be required to follow the same regulations as the employees.

34. **Mechanical Equipment.**—The mechanical equipment of slaughter-houses comprises a great variety of machinery, such as movable and stationary hoisting cranes, lifts, tackles, and hooks, by means of which the killed animals are suspended and moved about in order to dress them and cut them up; trucks and iron tanks placed on wheels are required for the removal of the hides and the offal; barrels and pails are provided for the blood; there must also be weighing scales, tables, and chopping-blocks. For the watering and flushing of the floors, by means of the inside hydrants, a large amount of rubber hose is required.

One of the most important parts of the mechanical equipment is the refrigerating or cold-storage plant, and a modern large abattoir can hardly be successfully operated without such. In fact, the success of large abattoirs began only with the introduction of the modern system of mechanical refrigeration, which enables the carcasses of animals to be chilled soon after killing, and which thus helps to keep the meat in a condition suitable for storage and transportation. It should also be mentioned that the development of the industry of shipping fresh-dressed beef was largely due to the introduction of the refrigerator cars on railroads.

35. **Sanitary Inspection Service.**—The sanitary inspec*tion* service of abattoirs comprises three principal divi-

sions, namely, first, the examination of the live stock before slaughtering, by veterinary surgeons; second, the inspection and microscopical examination of the meat of the slaughtered animals; and third, the sanitary inspection of the buildings and of the sanitary conditions in which they are maintained. It is the duty of the veterinary surgeons to watch the arriving cattle with a view of preventing the spread of cattle disease or the killing of diseased animals. All suspected cattle should be at once separated and removed to pens specially designed for diseased animals. The sanitary inspection service forms an important administrative question into which, however, it is not intended that this article should go.

The proper management of central abattoirs requires the strict enforcement of carefully drawn up rules and regulations. In the Rules and Regulations, governing the meat inspection, issued on June 30, 1906, by the United States Department of Agriculture, an attempt was made to cover to some extent the sanitation of the slaughtering-premises (see Appendix D). Considering the importance and the extent of the slaughtering industry of this country, the rules are not sufficiently elaborate or detailed. They show in some parts a lack of technical knowledge, but merit approval as being the first step in the right direction.

Note.—During a recent four months' trip in Europe, the author made visits of inspection to, and studied the plans and equipments of the municipal abattoirs in the following cities, viz.: Bremen, Hamburg, Berlin, Leipzig, Dresden, Freiburg, Frankfort-on-Main and

Antwerp. He was especially impressed with the excellent layout and the minute cleanliness maintained at the Frankfort-on-Main abattoir.

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A large book of 555 pages, ostensibly devoted to the subject given in the title page. The title of the book is somewhat misleading, for there is very little in this book about construction, equipment, and sanitation of modern abattoirs. It is rather a handbook on the subject of the packinghouse business. It gives in a convenient and simple form practical suggestions, tables and formulas which are needed in the operation of such plants. It describes in detail each operation in all the various ramifications of the business, from the unloading of the animals at the pens to the production of the finished meat food products. Valuable information is also given on the planning and arrangement of the various departments of the modern packing-house, but very little indeed is said about proper construction and the much-needed sanitation. Since the literature on this subject is very scant, one would suppose that in a book of this kind much stress would have been paid on the proper sanitation, the drainage, the sewerage, the disposal of the offal, the water supply, etc. If the author had this point in view at all, he entirely forgot to mention or to discuss the same. (W. P. G.)

Hearings before the Committe on Agriculture of the House of Representatives, United States, on "Conditions in the Chicago Stock Yards. 59th Congress, First Session, Washington, Government Printing Office, 1906.

This report contains the full report of Mr. James Bronson Reynolds and of Commissioner Charles Neill on Conditions in Chicago Stock Yards, together with other reports on Inspections, also the Hearings before the Committee.

Regulations governing the Meat Inspection of the United States Department of Agriculture. Issued under authority conferred on the Secretary of Agriculture by the Act of Congress approved June 30, 1906. Washington, Government Printing Office, 1906.

'Our Slaughter-House System—A Plea for Reform, and The German Abattoir." C. Cash and Hugo Heiss. London, 1907.

APPENDICES

APPENDICES

APPENDIX A

Fire Protection and Fire Prevention in Hospitals.

In General.—Hospitals should be provided with efficient fire protection and fire extinguishing-apparatus and appliances. Water for fire apparatus must be provided in ample volume and under a good fire pressure. The water pressure may be obtained:

(1) From a water reservoir, located at an elevation of at least 100 feet above the highest part of the buildings;

(2) from a stand-pipe or from an elevated water-tank;

(3) from house-tanks, located in high tank towers of the buildings;

(4) from underground pressure tanks in connection with compressed air-tanks;

(5) from direct pressure by pumping into the service mains;

(6) from special fire-pumps in the pump-house, connected with fire mains which supply the inside stand-pipes and fire valves, as well as the outside fire hydrants.

A large reserve of water, stored in elevated reservoirs or tanks, and instantly available in case of fire, is desirable. Where fire pressure is obtained by direct pumping, the pumping plant should always be provided in duplicate.

Water-tanks in the attics or towers of buildings must be safely supported on sufficiently strong steel I-beams, resting on the main walls of the building.

Fire-extinguishing Apparatus.—The fire-extinguishing plant of a hospital should comprise:

(*a*) inside fire apparatus;

(*b*) outside fire apparatus.

Inside Fire Apparatus.—A hospital should have the following appliances for inside fire protection, viz.: Lines of fire stand-pipes, with fire valves, fire hose, hose reels or racks, hose- or play-pipes, and nozzles, couplings and spanners; chemical and ordinary fire-pails and buckets of water; portable chemical or pneumatic fire-extinguishers; fire axes, hatches, saws, crow-bars, and fire-hooks, stored in glass cases; steam fire-extinguishing-pipes, and jets to the attics, controlled by valves, which should be placed in the cellar, preferably of another building than that in which the jet operates; these pipes to be connected with the high-pressure steam main; also an automatic sprinkler system.

Outside Fire Apparatus.—A hospital should be equipped with the following outside fire apparatus, viz.: Fire hydrants and water mains; hose carts, with 2½-inch fire-hose, spanners, and hydrant wrenches; chemical fire-engines; fire axes, hooks, saws; also some fire ladders; also with outside fire department connections *to* the inside fire stand-pipes.

Fire Pumps.—Fire-pumps should be either direct-acting duplex steam fire-pumps, of the "Underwriter" pattern, built extra strong and provided with steam and water ports of large areas; or they may be rotary steam or electric pumps.

Fire Mains and Water Mains.—Special fire mains should not be less than 8 inches inside diameter. Ordinary water mains, supplying outside fire hydrants, should not be less than 6 inches in diameter. The branches to single fire hydrants should be 4 inches, to double hydrants 6 inches.

Fire Hydrants.—The fire hydrants of a hospital should be of a uniform pattern, with standard fire department connections. All hydrants should be post hydrants, either single or double, anti-freezing and provided with frost cases. Each hydrant should be controlled by a separate gate-valve, and these should be provided with indicator-posts, or means for showing positively whether the underground valves are open or closed. These posts are better than ordinary valve-boxes and do away with the annoyance and delay occasioned by searching for a valve-box which may have been covered with dirt or snow.

The number of fire hydrants to be provided depends upon the size, number, and extent of the hospital buildings. The distance between the hydrants should not be more than 250 feet. It is true economy to provide a large number of hydrants, as the amount of fire-hose required will be thereby reduced. All hydrants should be provided with caps. Wrenches and spanners should be provided for operating the hydrants and are best kept on the hose carts.

Hydrants should be set far enough from the buildings to escape injury from falling walls, also to permit the men of the fire brigade to operate the hydrants during a fire.

All fire hydrants should be regularly tested and inspected, both in summer and in winter.

Fire Hose for Hydrants.—The fire hose for outdoor hydrants should be best quality rubber-lined cotton or linen fire-hose, 2½ inches inside diameter and provided with standard fire department couplings. All hose should be of make approved by the Board of Fire Underwriters.

For each hydrant provide at least 100 feet of hose. When operating the fire hose during a fire, remember that the shorter the line of hose, the less loss of pressure by friction will occur, and the more effective will the fire stream be.

Hose Carts.—The hose carts should be light yet strong, and of simple construction. Each hose cart should carry about 300 feet of fire-hose. The number of hose carts for a hospital depends upon the number of fire hydrants, but there should not be less than two hose carts.

Portable Chemical Engines.—Each hospital should have at least one portable chemical two-wheeled engine, of 50 gallons capacity.

Inside Fire Standpipes.—The hospital buildings should be equipped with inside fire stand-pipes. Each building should have from one to three lines, with outlets on each floor, including the basement and the attic.

The diameter of the stand-pipes should be from three *to four inches*; the material should be extra heavy galvanized screw-jointed wrought iron pipe. Stand-pipes should be located in halls and in heated staircases, but in no case where there is danger that the pipes would freeze.

The branches for inside fire-valves should be 1½ inches, and the outlets should be placed about 6½ feet from the floor line, to bring the fire-valve out of reach of patients.

In the basement, the fire stand-pipes should be connected with the supply mains of each building. The running lines in the basement should be preferably placed below the cellar floor, at such a depth as to be safe from injury from falling walls.

Fire Valves.—Fire valves should be extra heavy brass or steam metal fire valves, of the full waterway or gate pattern, and not globe valves. The size of fire-valves for use on the fire stand-pipes should be 1½ inches.

Fire Hose for Inside Use.—The fire-hose for inside use should be best quality unlined linen fire-hose, warranted not to leak and to stand a pressure of 400 pounds per square inch. All fire-hose should be of quality approved by the Board of Underwriters and in accordance with their special specifications. A good twilled cotton rubber-lined fire hose is also to be approved, provided the rubber lining is not too heavy. The inside diameter of all fire hose for inside use should be 1½ inches.

Hose Reels or Racks, Hose Couplings and Fire Nozzles.—All inside fire hose should be supported on hose reels or racks. At each hose reel or fire-valve a hose spanner should be provided. The fire hose should have standard couplings.

At each fire-valve provide in connection with the fire hose a brass or nickel-plated fire nozzle, same to be at least 15 inches long, smooth on the inside, of standard fire department pattern, and with either 1 inch or $1\frac{1}{8}$ inch nozzle opening.

Fire Pails.—Each ward of a hospital should be provided with at least six fire pails, which must be constantly kept filled. Fire pails should be durable, light and strong, with rounded bottoms, and set on shelves. A few special chemical fire pails might also be kept handy in addition to the regular pails.

Chemical and Pneumatic Hand Extinguishers.—The small portable hand-extinguishers are useful and to be recommended for hospitals. They should be kept under lock and key, and the key should be in the hands of the head attendant or nurse of each ward.

The pneumatic fire extinguishers are less dangerous to handle than chemical extinguishers; the damage, when they are brought into use, is also apt to be less.

Automatic Sprinkler System.—In the specially hazardous parts of a hospital, such as the laundry, the workshop, attics with mansard windows, etc., a wet-pipe automatic sprinkler system may be installed. The sprinkler equipment should be complete in every respect and should conform to the standard requirements of the Board of Fire Underwriters.

Fire-alarm System.—A hospital should be provided with a fire-alarm system, and fire alarm boxes should be placed in every building; also at suitable points on the outside of the hospital. The signal-boxes should be numbered and painted a bright red, so as to be easily found in an emergency. Each of the attendants of the hospital should be provided with a pass-key for the boxes, and the keys should be registered in the superintendent's central office.

The engine- or pump-room, or the power-house, should be provided with alarm gong and indicator; also with a fire whistle.

Besides this, the hospital should always have telegraphic and telephonic communication with the city fire-department headquarters.

Hose Tower and House.—It is a good plan to provide for the hospital a hose-house, containing the hose carts, the portable chemical fire-engine, fire hooks, axes, poles, etc., and a room for a hose rack for drying the hose after use. A hose-tower, at least 50 feet high, is recommended for the latter purpose.

Hospital Fire Brigade.—A hospital should have a well-organized and drilled private or hospital fire brigade. Hospitals within the city limits do not require as full an equipment as those located at the outskirts or in the country.

All hospital attendants and employees should be instructed in the use and handling of the hospital fire apparatus. In case of an outbreak of fire each man should have a fixed designated place, and a known duty to perform.

Practice drills should be held at regular intervals, and also occasionally without previous notice.

The hospital should issue a special "*fire manual*," with which every employee should make himself familiar.

Fire Districts.—Plan of Districts; Location of Hydrants and Fire Alarm Boxes.—A large hospital, composed of a group of buildings, should be divided into fire districts. A plan or map of the hospital and grounds should be prepared to show the division into fire districts, also the location of all outside hydrants, inside fire-valves and of the fire-alarm boxes.

The plan should also show the water supply system, the special fire mains if any are provided, also the location of the fire-pump, of the hose house, etc.

Fire Escapes and Fireproof Stairs.—Each of the buildings of a hospital should have at least two separate and independent staircases. Each of the larger wards should have two exits with doors opening outwards. The buildings should also be provided with approved outside fire-escapes, of such construction that they may be safely used by those patients who are not confined to their beds.

Rules as to Fire Prevention.—A hospital should have some printed rules on fire prevention, which every employee and each nurse should study. The rules should relate to the use and care of matches, of oily rags and wastes, to the management of the heating apparatus and of the steam-pipes, to the electric light wiring, the care of laundries, and drying rooms, etc.

I quote a few paragraphs from such rules prepared by an English firm of manufacturers of fire protection apparatus:

"It is intended that the following rules should be frequently and carefully considered by all employed on the hospital premises:

Precautions Against Fire.

Matches and Tapers.—"Great caution is necessary in the use of matches and tapers, the safe extinction of which after use should be made certain. Only the so-called "safety" matches should be used in a hospital.

Watchman's Lamp.—"A covered light or watchman's lamp should be used, not only by the watchman, but by the attendants, on night duty.

Smoking.—"In hospitals and other public institutions smoking should be permitted only in the apartments specially reserved for this purpose.

Fires in Grates.—"Fires in open fire-places and grates should not be taken out or raked out on the hearth, but the embers should be put back in such a way as to prevent their falling off, thus allowing the fire to die out in its proper place. Wood or other fuel, intended to be used in the grate the next morning, should not be placed in close proximity to the heated grate.

Flues.—"Care should be taken that flues are properly constructed and kept clean.

Gas.—Gas Leakage.—Jointed Gas Brackets.—"Gas should be carefully turned out when no longer required. If an escape of gas occurs, the doors and windows should be opened at once. The gas leak should be traced by the sense of smell only if possible. The greatest caution should be employed in the introduction of a light. This should never be used until windows and doors have been kept open for some time, while the gas has been turned off at the main gas meter.

"Care should be taken that no inflammable material is within reach of any jointed gas brackets.

Accumulation of Waste Material.—"The accumulation of waste material of any description should on no account be permitted in any part of the premises. Fires have been caused by the throwing of hot ashes into dust bins.

Smell of Fire not to be Disregarded.—"On no account should the slightest smell of fire or smoke be allowed to pass unheeded, but the cause should at once be ascertained. Many serious fires, caused by defective hearths and flues, stove-pipes passing through floors or walls, etc., might have been subdued at their outbreak if this precaution had been attended to.

Everyone Should be Used to the Fire Appliances.—Fire Drill.—"Every person employed on the premises should be made acquainted with the use and positions of the fire hydrants, fire valves, and other fire protection apparatus in the building. This apparatus should be thoroughly overhauled and cleaned at least four times a year. These occasions would be convenient opportunities for fire drill.

"Everyone should be fully instructed as to an alternative means of escape, in case the flight by the ordinary staircase should be cut off. All apparatus necessary for this purpose should be periodically inspected and tested.

In Case of an Outbreak of Fire.

Extinguishing Fire.—"A jet from a portable hand extinguisher will frequently be sufficient to subdue a *fire in* its incipiency, or a pail of water may be used with good results, but in any case the hose from the nearest stand-pipe fire valve should, in the meantime, be run out. The hose nozzle should be brought as near to the fire as possible, in order that the full force of the jet may be utilized. Sudden bends or kinks in the hose should be avoided, as they not only reduce the water pressure at the nozzle, but also place the hose in danger of bursting. Care should always be taken to avoid unnecessary damage by a too plentiful application of water.

Removal of Inmates.—"If the fire is judged to be dangerous, it will be of the utmost importance to secure the immediate removal from the premises of all persons except those engaged in extinguishing the fire or removing property. The fact of a fire having broken out should be conveyed to the sick as calmly as possible.

Escape.—"If patients of a hospital are in bed at the time of an outbreak of fire, they should be dressed by the attendants with whatever is readily available, and on leaving the rooms, all the doors should be closed. The escape should be effected either by the regular stairs, if possible, of else, if this is no longer possible, the alternative measures previously arranged for, by the roof, or by fire escapes, should be at once made use of.

Send Alarm to Nearest Fire Station.—"An attendant should at once give the alarm to the nearest fire engine-house, without waiting to see whether those on the spot are likely to be able to extinguish the fire or not.

Keep Doors Shut.—"It is of the utmost importance to shut, as far as possible, and keep shut, all doors, windows, and other openings to the outer air.

Free Breathing.—"In the midst of much smoke, the air is comparatively clear towards the floor, consequently progress may be made on the hands and knees, keeping the face as low as possible. A wet silk handkerchief, sponge, worsted stocking, or other flannel substance, drawn over the mouth and the nostrils, permits free breathing, and to a great extent excludes the smoke from the lungs.

Turn Off the Gas at the Meter.—"Should the outbreak of fire promise to be serious, the gas should be turned off at the meter.

Coolness and Presence of Mind.—"The want of coolness and presence of mind on such occasions is by far the greatest hindrance to the preservation of life and property. In dealing with fire, a cool judgment and steady perseverance are far more effective than any impetuous and fitful exertions that may be made.

Clothing on Fire.—"In the case of the clothes of the person of any one taking fire, a hearth rug or blanket or anything else similar readily available should be at once rolled around the body, thus smothering and crushing out the flames. If there be no helper at hand, the person whose clothes are in flames, should roll himself or herself over and over on the floor. On no account should he or she rush about from one room to another, for this, of course, only fans the flames into more fury and makes the consequences more serious."

Many of the foregoing rules and hints are also applicable to school buildings.

For *further particulars* on this subject see:

DR. P. M. WISE, "Fire Manual of the St. Lawrence State Hospital."

L. H. PRINCE, "The Fire Protection of Hospitals for Insane."

WM. PAUL GERHARD, "The Prevention of Fire, chiefly with reference to Hospitals and other Public Institutions."

WM. PAUL GERHARD, "Theatre Fires and Panics; Their Causes and Prevention."

APPENDIX B.

From a report by H. Endemann, Ph.D., on "Chemical Examination of the Air of Various Public Buildings," the following notes are taken relative to air contamination in some of the theatres of New York City. This matter appeared in the third annual report of the New York Board of Health in 1873.

"In examining the air of theatres and public halls, it is to be taken into consideration that in these cases we have two sources for the carbonic acid in the air, the one being respiration, the other the combustion of illuminating gas. The latter item, on examination, proved to be of immense importance.

"In some special cases, the proportion was approximately determined with the aid of the theatre statistics, giving the number of persons present in the theatre on the particular evening when the examination was made, and the amount of gas consumed per hour. It was thus ascertained that, in one theatre with slim attendance, the proportion of carbonic acid formed by respiration to that formed by combustion of gas was as 1 to 7. In another theatre, with a full house, the proportion was found to be as 1 to 4½, and even in the most crowded and poorest illuminated theatres the proportion would not become less than 1 to 2, so that even under the

Date.	Time.	Theatre or Hall.	Part of House.	CO_2 in 10,000 Parts of Air.	Number in Audience.
March 27, 1872.....	9 P.M.	Tony Pastor's	Gallery	37.1	Full house
March 27, 1872.....	9.30 P.M.	Tony Pastor's	Parterre	29.8	Full house
March 27, 1872.....	9.50 P.M.	Atlantic Garden	Parterre	18.75	Full house
March 29, 1872.....	8.45 P.M.	Stadt Theatre	Gallery	19.1	Slim attendance
March 29, 1872.....	8.53 P.M.	Stadt Theatre	Parterre	27.7	Slim attendance
March 29, 1872.....	9.00 P.M.	Bowery Theatre	Gallery	36.5	Crowded house
March 29, 1872.....	9.05 P.M.	Bowery Theatre	Parterre	23.2	Crowded house
March 31, 1872.....	9.35 P.M.	Union Square Theatre	Gallery	28.9	Moderately full
March 31, 1872.....	9.00 P.M.	Cooper Institute Hall	Parterre	27.0	Moderately full
March 31, 1872.....	9.20 P.M.	Germania Theatre	Parterre	26.0	Full house
April 4, 1872.......	9.30 P.M.	Niblo's Garden	Balcony	33.9	Full house
April 4, 1872.......	9.15 P.M.	Wallack's Theatre	Gallery	36.5	Full house
April 9, 1872.......	9.15 P.M.	Booth's Theatre	Balcony	10.6	Moderately full
April 9, 1872.......	9.15 P.M.	Olympic Theatre	Balcony	20.0	Full house
April 9, 1872.......	8.45 P.M.	Fifth Avenue Theatre	Gallery	40.6	Full house
April 9, 1872.......	8.45 P.M.	Fifth Avenue Theatre	Parterre	14.2	Full house
April 11, 1872......	8.30 P.M.	Athenæum Theatre	Partérre	13.0	Full house
April 11, 1872......	9.00 P.M.	Bryant Theatre	Parterre	17.0	Full house
April 11, 1872......	9.15 P.M.	Grand Opera House	Parterre	11.8	Slim attendance
April 11, 1872......	9.25 P.M.	Grand Opera House	Balcony	23.7	Slim attendance

least favorable circumstances, but one-third of all the carbonic acid found could be due to respiration. Taking it for granted that the dangerous properties of a vitiated atmosphere grow more in proportion to the organic vapor present than with the carbonic acid alone, the importance of this consideration becomes at once evident."

The preceding tabulated statement gives the results obtained.

APPENDIX C.

In the year 1905, the New York Butchers' Dressed Meat Company opened its new abattoirs, located in Eleventh Avenue, between Thirty-ninth and Fortieth Streets, a plant representing an outlay of one and one-half millions of dollars, and which is said to be the most complete of its kind in the United States. The following short description of it is taken from the *New York Times:*

"The main building, of brick and iron, is six stories high. It is connected with the company's own piers at the foot of West Thirty-ninth Street.

"When the steers are driven from the cars a gate is closed behind them at Thirty-ninth Street and Eleventh Avenue, and they follow two big white bell wethers up a series of inclines until they arrive on the roof of the big building where the pens are located.

"On a mezzanine floor, also open to the air and below the beef pens, are pens for calves, sheep, and lambs. No hogs are slaughtered, as the whole establishment is carried on in "kosher" fashion.

'On the floor below the roof is the slaughtering room, with the newest machinery. This room is 20 feet high, and so arranged that all offal is at once disposed of. Every bit of the by-product, down to the last tuft of hair, is utilized.

"The killing is done by eight 'schochets', or licensed slaughterers, under the supervision of Rabbi Philip Klein, who sees to it that every detail of the Mosaic law is carried out.

"The steers are driven into small pens ranged on one side of the room. The 'schochet' passes his long keen-edged knife to the head-man, who carefully tries it on his thumb nail to see that there is no nick in its keen edge. Should a killer use a nicked knife the meat would be 'trafe' and could not be eaten by the orthodox Jews.

"Suddenly the door of the pen raises. Quick as a flash a butcher has thrown a chain round the hind legs of the steer, and by touching a button the huge body is whirled into the air. As the head swings around the 'schochet' draws his long knife across the animal's throat, severing the windpipe and jugular vein. It is claimed that this is the most humane and cleanly method of slaughtering.

"Then the butchers get to work, and in a twinkling the halves of the beef are hanging on trolleys ready to be taken down to the refrigerating rooms. There are fifteen of these rooms in the building, in which a temperature of 34 degrees Fahrenheit is maintained. The rooms have a capacity of 14,000 quarters of beef. Exactly the same methods are used in killing the small animal stock, the carcasses of which are kept in separate cooling rooms.

"Across the street, at the corner of Thirty-ninth Street and Eleventh Avenue, is the poultry department. This department is not under the 'kosher' law.

"In the near future the company will receive carcasses from independent packers in the West and distribute them on commission. The capacity is now 4000 carcasses a week, although but 2500 cattle will be slaughtered for some time."

Very complete technical and illustrated descriptions of this model abattoir are given in the *Engineering Record* of June 30, 1906, and in *The American Architect* of June 20, 1906.

The following description of a model slaughter-house equipped with a refrigerating plant, is quoted from the *American Architect:*

"This plant was designed to be erected in the City of New Orleans, and comprises a stockyard, a slaughter house, and salesrooms both for local trade and for shipping by refrigerator cars. It is fitted out with all the latest scientific and sanitary appliances used for handling the stock in the best manner, housing them to the best advantage in the stockyards, and for killing them in the slaughterhouse.

"The most interesting and most important part of the plant is the several stages of cooling to which the meat is subjected before it is in shape to keep any length of time or to be used at once. The plant is planned to allow the increasing of the capacity by the simple addition of adjoining buildings, without in the least interfering with the present arrangements of the slaughter-houses and refrigerators; space being left in the engine-room for an additional refrigerating-machine and for brine tanks. The last-named is the secret of the success of the business of preparing refrigerated meat. Ice itself is not used at all, but the slaughterhouses, the chill rooms, the storage- and salesrooms are so supplied with pipes from the refrigerating-machine as to allow these several rooms to be kept at the several required temperatures. The meat, as it comes from the killing beds, is allowed to stand a certain length of time, in accordance with the temperature of the atmosphere, after which it is placed in the cooling boxes or chilling rooms to remove the animal heat. It is then taken to the wholesale store rooms, which are kept at a temperature allowing it to be preserved for an almost indefinite length of time if so desired.

"From the store-rooms, in which the meat hangs very close together, it is removed to the retail store-rooms or show-rooms, where it hangs on each side of an alley, down which the salesman and purchaser walk to inspect the meat. After the purchase, the beef, mutton, lamb, pork, or veal, is taken off the show tracks, hung on the delivery track and sent out to the sales-room, where after being weighed it is removed by the buyer, sent back to the refrigerator for temporary storage, or else shipped in the refrigerator-cars.

"During all this progress, from the killing-beds in the slaughter-house to the buyers' wagon or car, the meat is suspended from an overhead single-track railroad, hung to hooks on rollers, which travel on the overhead tracks.

"The tracks are continued from the beds out over the scales and down to the corner doors and into the several refrigerators, with numerous switches, branches, cut-outs, etc., needed to move the meat without lifting it by hand.

"The slaughter-houses are fitted up with exhaust fans for mechanical ventilation, to assist the natural ventilation in very hot weather. They have water-tight floors, separate pipes for blood and waste, a platform upon which the offal is wheeled and dumped into a car, and then it travels on the railroad tracks to the rendering-house, which is well removed from the refrigerators.

"The abattoirs have improved catch-pens, power from the engine in the power-house, abundance of light and ventilation from side windows through slat headlights, and turret or monitor skylights. The refrigerators are insulated with asphaltum sheathing paper and $\frac{7}{8}''$ tongued and grooved boards, forming a series of air spaces, the doors being some 6 or 8 inches thick, with air spaces and rubber on edges, and the windows having four sashes, all being as near to air-tight as possible.

"An important feature of the plant is the fact of its being built on the slow-burning construction principle. That is, the first floor is 5 or 6 inches thick and rests on girders about 8 or 9 feet apart, the roof being formed the same way, with 3 or 4 inch planks and girders about 10 feet apart. The advantages of this method of building are many, chief among which is the fact of there being no enclosed spaces for the harboring of vermins as in the ordinary construction, and the rates of insurance being greatly in its favor, as is shown by the rates on the mills built in this manner. The particular benefit of this timber flooring in refrigerators is not so much the reduction of insurance, which, of course, is low from the nature of the business, and the use of electric lights, but because by using this flooring the hangers by which the tracks are supported can be placed in any spot, regardless of the beams and girders; whereas the old method of securing the hangers was to locate the floor-joists with reference especially to the tracks, and in making the necessary curves and switches this was a very difficult task.

"This plant is arranged with the view of having the business center at the office building, on each side of which are *the salesrooms*, one for beef and for small stock (meaning mutton, lamb, veal, and pork), each being kept in separate departments. The office building, also built on the slow-burning principle, is a very substantial structure and has in the upper portion a large tank, supplied from a pump in the power-house and having pipes extending in every direction to supply the several fixtures in the usual way and out to the troughs in stock-yards and to the slaughter-houses, with large fire-plugs and hose-pipe at suitable spots for a fire-guard as well. The tank-house is thoroughly ventilated by the tower-house.

"The plant is supplied with a large power-house containing the several pumps, dynamo, engine, refrigerating machines, and the brine tanks. Adjoining is the chimney-stack and boiler-room, with coal-sheds attached.

"The rendering-house and granary stand on the railroad track and the whole plant is enclosed with a stockade, except where the main buildings run out to the street line.

"These last are designed in a style of architecture very suitable to the particular locality, being an adaptation of Spanish Renaissance, and taken as a whole make a pleasing impression. The architect has made a special study of this class of buildings and believes he has succeeded in combining a satisfactory exterior with an interior in which are combined special features that are very necessary in the business, a business, by the way, which in the good old times was relegated to the most out-of-the-way place, in any old tumbled-down building, in every community, and to be shunned because of the supposed necessity of the accompanying filth and odors. But, as now conducted in the most improved slaughter-houses it is obliged to be as cleanly as any other producing industry. The Government has inspectors to pass on every animal killed and tag all meat before it can be exposed for sale, and the competition in this business, as in all others, compels the men in it to use every effort to produce the best results, which means good wholesome meat prepared with the cleanest possible surroundings and put in the most attractive shape."

APPENDIX D.

Extract from "Regulations governing the Meat Inspection of the United States Department of Agriculture."

(Issued under authority conferred on the Secretary of Agriculture by the act of Congress, approved June 30, 1906.)

SANITATION.

REGULATION 10.—Upon receipt of an application for inspection, the Secretary of Agriculture will cause to be made an examination of the premises, and will indicate the requirements for sanitation and the necessary facilities for inspection.

REGULATION 11.—In order that the carcasses of cattle, sheep, swine, and goats, and the meats and meat food products thereof, may be admitted to interstate or foreign commerce, it is necessary under the law that the establishments in which the animals are slaughtered, or the meats and meat food products are prepared, cured, packed, stored, or handled, shall be suitably lighted and ventilated and maintained in a sanitary condition. All work in sueh establishments shall be performed in a cleanly and sanitary manner.

(*a*) Ceilings, side walls, pillars, partitions, etc., shall be frequently whitewashed or painted, or, where this is impracticable, they shall, when necessary, be washed, scraped, or otherwise rendered sanitary. Where floors or other parts of a building, or tables or other parts of the equipment, are so old or in such condition that they cannot be readily made sanitary, they shall be removed and replaced by suitable materials or otherwise put in a condition acceptable to the inspector in charge. All floors upon which meats are piled during the process of curing shall be so constructed that they can be kept in a clean and sanitary condition, and such meats shall also be kept clean.

(*b*) All trucks, trays, and other receptacles, all chutes, platforms, racks, tables, etc., and all knives, saws, cleavers, and other tools, and all utensils and machinery used in moving, handling, cutting, chopping, mixing, canning, or other process, shall be thoroughly cleansed daily, if used.

(*c*) The aprons, smocks, or other outer clothing of employees who handle meat in contact with such clothing shall be of a material that is readily cleaned and made sanitary, and shall be cleansed daily, if used. Employees who handle meats or meat-food products shall be required to keep their hands clean.

(*d*) All toilet-rooms, urinals, and dressing-rooms shall be entirely separated from compartments in which carcasses are dressed or meats or meat-food products are cured, stored, packed, handled or prepared. They shall be sufficient in number, ample in size, and fitted with modern lavatory accommodations, including toilet paper, soap, running-water, towels, etc.. They shall be properly lighted, suitably ventilated, and kept in a sanitary condition. Managers of establishments must see that employees keep themselves clean.*

(*e*) The rooms or compartments in which meats or meat-food products are prepared, cured, stored, packed, or otherwise handled, shall be lighted and ventilated in a manner acceptable to the inspector in charge and shall be so located that odors from toilet-rooms, catch basins, casing departments, tank-rooms, hide-cellars, etc., do not permeate them. All rooms or compartments shall be provided with cuspidors, which employees who expectorate shall be required to use.

(*f*) Persons affected with tuberculosis or any other communicable disease shall not be knowingly employed in any of the departments of establishments where carcasses are dressed, meats handled, or meat-food products prepared, and any employee suspected of being so affected shall be so reported by the inspector in charge to the manager of the establishment and to the Chief of the Bureau of Animal Industry.

(*g*) The fattening of hogs or other animals on the refuse of slaughter-houses will not be permitted on the premises of an establishment where inspection is maintained, and no use incompatible with proper sanitation shall be made of any

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* This paragraph omits the very important requirement that toilet-rooms must be provided entirely *separate* for men and for women. W. P. G.

part of the premises on which such establishment is located. All yards, fences, pens, chutes, alleys, etc., belonging to the premises of such establishment shall, whether they are used or not, be maintained in a sanitary condition.

(*h*) Butchers who dress diseased carcasses shall cleanse their hands of all grease and then immerse them in a prescribed disinfectant and rinse them in clear water before engaging again in dressing or handling healthy carcasses. All butchers' implements used in dressing diseased carcasses shall be cleansed of all grease and then sterilized, either in boiling water or by immersion in a prescribed disinfectant, and rinsed in clear water before again being used in dressing healthy carcasses.

Facilities for such cleansing and disinfection, approved by the inspector in charge, shall be provided by the establishment. Separate trucks, etc., shall be furnished for handling diseased carcasses and parts. Following the slaughter of an animal affected with an infectious disease a stop shall be made until the implements have been cleansed and disinfected, unless duplicate implements are provided.

(*i*) Inspectors are required to furnish their own knives for use in dissecting or incising diseased carcasses or parts, and are required to use the same means for disinfecting knives, hands, etc., that are prescribed for employees of the establishment.

(*j*) Meats and meat-food products intended for rendering into edible products must be prevented from falling on the floor, while being emptied into the tanks, by the use of some device, such as a metal funnel.

(*k*) Plans of new plants and of plants to be remodeled should be submitted to the Secretary of Agriculture.

Extracts from "Definitions of Words and Terms."

Carcass.—This word shall mean an animal that has been killed under these regulations, including all parts which are to be used for food.

Primal Parts of Carcass.—This phrase shall mean the usual sections or cuts of the dressed carcass commonly known in the trade, such as sides, quarters, shoulders, hams, backs, bellies, etc., and entire edible organs, such as tongues, livers, etc., before they have been cut, shredded, or otherwise subdivided preliminary to use in the manufacture of meat-food products.

MEAT-FOOD PRODUCTS.—This term shall mean any product used for food into the composition of which any portion of the carcass enters, or in the preparation of which any portion of the carcass is used, including lard, mince-meat, extracts, gelatin, oleomargarine, butterine, soups, etc.

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